APPENDIX F

Final Cumulative Effects Assessment

NORTH TOPSAIL BEACH SHORELINE PROTECTION PROJECT
FINAL CUMULATIVE EFFECTS ASSESSMENT

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NORTH TOPSAIL BEACH SHORELINE PROTECTION PROJECT
FINAL CUMULATIVE EFFECTS ASSESSMENT

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The Council on Environmental Quality (CEQ) defines cumulative effects as *the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable actions regardless of what agency (Federal or non-Federal) or person undertakes such other action* (40 CFR 1508.7). The following report describes the methods, rationale, and results of the Cumulative Effects Assessment for the proposed North Topsail Beach Shoreline Protection Project in terms of the eleven (11) step process identified by the CEQ (CEQ, 1997).

Environmental Impact Assessment Components	**Cumulative Effects Analysis Steps**
Scoping	1. Identify the significant cumulative effects issues associated with the proposed action and define the assessment goals.
	2. Establish the geographic scope for the analysis.
	3. Establish the time frame for the analysis.
	4. Identify other actions affecting the resources, ecosystems, and human communities of concern.
Describing the Affected Environment	5. Characterize the resources, ecosystems, and human communities identified in scoping in terms of their response to change and capacity to withstand stresses.
	6. Characterize the stresses affecting these resources, ecosystems, and human communities and their relation to regulatory thresholds.
	7. Define a baseline condition for the resources, ecosystems, and human communities.
Determining the Environmental Consequences	8. Identify the important cause-and-effect relationships between human activities and resources, ecosystems, and human communities.
	9. Determine the magnitude and significance of cumulative effects.
	10. Modify or add alternatives to avoid, minimize, or mitigate significant cumulative effects.
	11. Monitor the cumulative effects of the selected alternative and adapt management.

As suggested by the CEQ, it is the goal of this report to "tease from the complex networks of possible interactions those that substantially affect the resources." (CEQ, 1997).

1. Significant Cumulative Effects Issues and the Assessment Goals

The goal of the National Environmental Policy Act (NEPA) process is to reduce adverse environmental effects, including cumulative effects. Cumulative effects analysis is an iterative process in which consequences are assessed repeatedly following incorporation of avoidance, minimization, and mitigation measures into the alternatives considered Monitoring is the last step in determining the cumulative effects that ultimately results from the action. The significance of cumulative effects depends upon the ecosystem, resource baseline conditions, and relevant resource stress thresholds (CEQ, 1997).

Cumulative impacts result from spatial (concentration of a multiple impacts in a given area) and temporal (repeated occurrence of impacts in a given area) crowding of environmental perturbations. In general, many environmental effects could be considered as cumulative and almost all systems have already been modified, degraded or enhanced, through anthropogenic forces.

Resource Issues and Assessment

The proposed project (Figure 1, Alternative 3 - Applicant's Preferred Alternative), in addition to past projects and any reasonable foreseeable future actions (RFFA), primarily affects the following resources: human community; beach; infaunal species; shorebirds, crustaceans, and sea turtles; intertidal flats and shoals; salt marshes; nearshore hardbottom resources; offshore borrow areas and adjacent hardbottom resources; and the water column.

Human Community Resource

In general, beach nourishment projects have intermediate to long-term impacts on the human community. These projects interrupt natural and anthropogenic induced erosion and recession of the shoreline. They provide storm protection to dwellings and infrastructure while increasing coastal recreational area. These projects facilitate development of the coast where it is permitted. These positive impacts for the human community can have negative impacts on other resources whose habitats or life stage activities are directly or indirectly impacted through human activity.

Beach Resource and Associated Shorebird, Crustacean, and Sea Turtle Resources

The beachfront shoreline is comprised of three main systems: dune, dry beach, and wet beach. Sand dunes and vegetation that comprise the dune system provide protection to structures from storm surge, and habitat for wildlife. The dry beach, located between the toe of dune or scarp and the Mean High Water Line (MHWL) provides recreational areas for humans and nesting sites for sea turtles and shorebirds. The wet beach (between Mean Low Water Line (MLWL) and MHWL provides recreational areas for humans, habitat for infauna and foraging areas for shorebirds, crustaceans and fish.

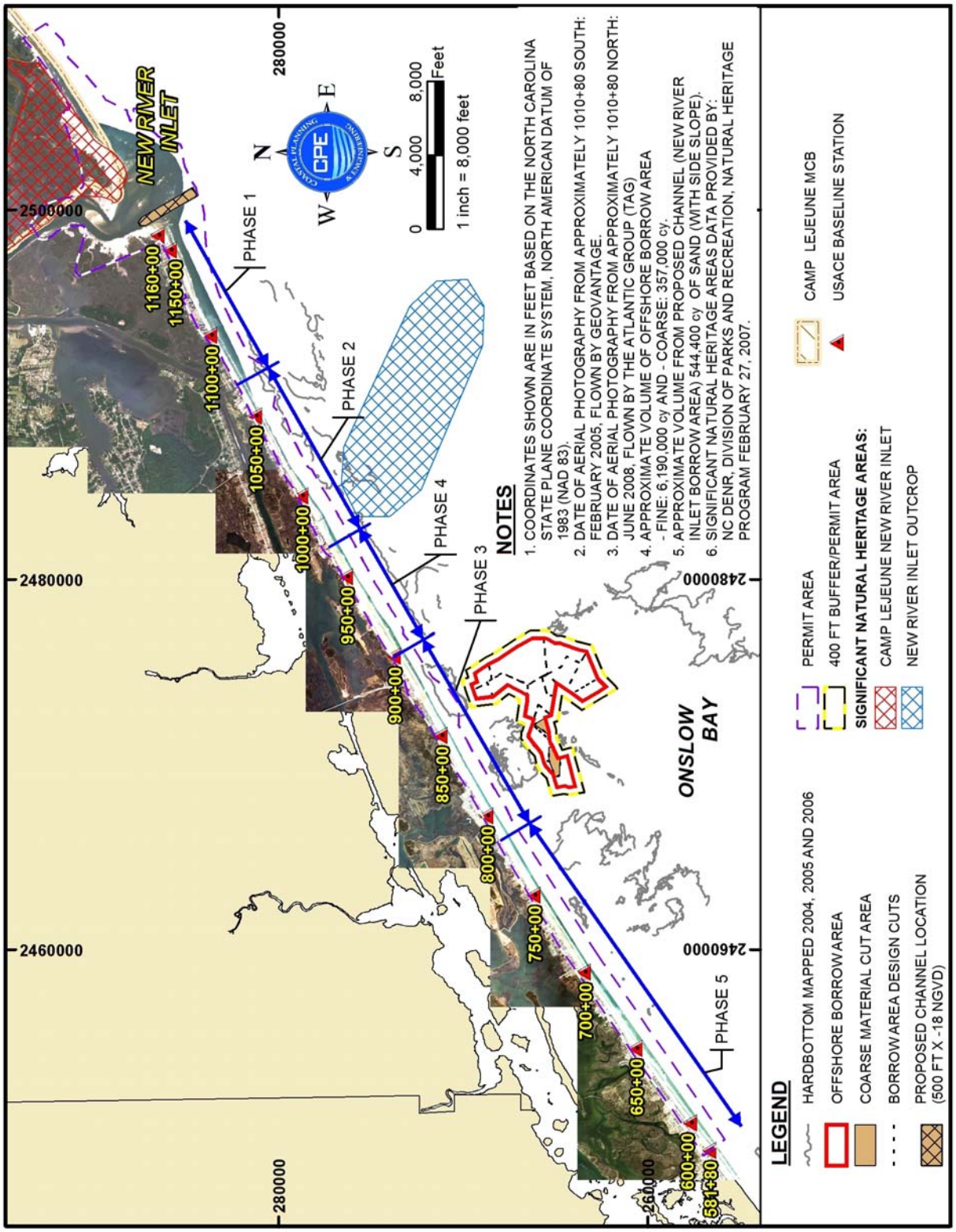

Figure 1 - North Topsail Beach Shoreline Protection Project Location Map

Infaunal Species Resource

Infaunal species will experience short to intermediate-term impacts resulting from direct burial and associated localized elevated turbidity adjacent to the fill area. Short to intermediate-term impacts directly affect shorebird, crustacean and fish foraging along with impacting recreational fishing through a reduction in bait species.

Intertidal Flats and Shoals Resource

Intertidal flats and shoals are habitat for migratory shorebirds, colonial waterbirds, marine mammals, reptiles, crustaceans and fish. These habitats represent a dynamic ecosystem to which the above species have adapted. These habitats will be directly impacted (through removal) by the proposed project and foreseeable future projects (including maintenance dredging every four years).

Salt Marsh Resource

Salt marsh communities are comprised of regularly and irregularly flooded lands located throughout the sounds, creeks and rivers of North Carolina. Short-term impacts of turbidity and sedimentation will occur adjacent to beach fill sites within proximity of the project area. There is a potential for impacting salt marsh communities adjacent to New River Inlet. Short-term impacts may be difficult to differentiate from that associated with high wave energy activity in the inlet. Short-term impacts include partial burial of habitat and temporary displacement of foraging species. There is a potential for cumulative effects from foreseeable future projects (including maintenance dredging of New River Inlet every four years).

Nearshore Hardbottom Resource

Nearshore hardbottom habitats can be affected by localized, short-term impacts of turbidity and sedimentation which occur adjacent to beach fill sites. The proposed project will incorporate a perched beach in the vicinity of nearshore hardbottom habitat. The utilization of coarse material will minimize the migration of material offshore thereby reducing the potential for direct burial of nearshore hardbottom resources. The potential for future foreseeable projects to impact nearshore hardbottom is directly related to the percentage of silt and fine grain sediment being dredged and transferred to other locations. Because this habitat type is geographically limited within the region, any negative impacts incurred could result in cumulative impacts. However, due to a number of minimization and avoidance measures along with the implementation of a monitoring plan, long-term direct or indirect impacts to nearshore hardbottom are not expected.

Offshore Hardbottom Resource

Local, short-term impacts of turbidity and sedimentation occur in areas adjacent to offshore borrow sites. In order to minimize these impacts on adjacent offshore hardbottom habitat, utilization of a cutterhead suction dredge and 400 foot buffer zone have been proposed for the project. Because this habitat type is geographically limited within the region, any negative impacts incurred could result in cumulative impacts. However, due to a number of minimization and avoidance measures along with the implementation of a monitoring plan, long-term direct or indirect impacts to nearshore hardbottom are not expected.

Water Column Resource

Localized, short-term impacts to the water column will occur at the cutterhead dredge operating location and at fill disposal sites. Natural conditions support fluctuating turbidity levels (9.7 to 35.2 Nephelometric Turbidity Units) in the nearshore and offshore water column of the project area. These fluctuating turbidity levels would continue with or without the proposed project. The dredging of the realigned inlet and offshore borrow area is not anticipated to increase turbidity above these dynamic conditions beyond the immediate construction time frame. There is a potential for cumulative effects in nearshore waters if multiple beach fill operations occur simultaneously within the Onslow Embayment.

2. Geographic Scope

This analysis will focus on the applicable geographic range per resource. The North Carolina coastline has been defined as the geographic range per resource. This delineation is derived from the predominant migratory routes, habitat ranges of species' potentially affected by the proposed project, oceanic circulation patterns and demographics.

Human Community Resource

The United Nations Atlas of the Oceans reports that "In the United States, around 53% of the population lives near the coast and since 1970 there have been 2000 homes per day erected in coastal areas." (UN, 2006). The primary objective of the proposed project is coastal protection of the North Topsail Beach shoreline. The cumulative effects of past, present and reasonable foreseeable future projects (RFFPs) are to facilitate human coastal habitation and recreation. The geographic scope for this resource (humans) is the North Carolina coast shoreline.

Beach Resource

The geographic scope for the beach resource (dune, dry beach and wet beach) and affiliated organisms is the North Carolina coast.

Infaunal Species Resource

The geographic scope for infaunal species is the North Carolina Coast.

Shorebird Resource

The geographic scope for breeding, overwintering and/or foraging areas for federally threatened (piping plover (*Charadrius melodus*) and endangered roseate tern (*Sterna dougallii*) shorebirds and for State designated threatened species (gull-billed tern [*Sterna nilotica*]) or species of special concern in North Carolina, (Wilson's plover [*Charadrius wilsonia*], least tern [*Sterna antillarum*], common tern *[Sterna hirundo*] and black skimmer [*Rynchops niger*]) is the eastern coast of North Carolina and migratory coastal routes north and south of the State.

Sea Turtle Resource
The geographic scope for nesting sites of the endangered leatherback (*Dermochelys coriacea*), threatened loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) sea turtle resources is coastal North Carolina.

Intertidal Flats and Shoals Resource
The geographic scope for the intertidal flats and shoals resource is developed coastal beaches adjacent to inlets along the North Carolina coast.

Salt Marsh Resource
The geographic scope for the salt marsh ecosystem resource is developed coastal beaches adjacent to inlets along the North Carolina coast.

Nearshore Hardbottom Resource
The geographic scope for nearshore (<514 m from toe of dune and ~5 to 7 m deep) hardbottom epibenthic and fish community resources is the nearshore coastal area in the vicinity of developed beaches along the North Carolina coast.

Offshore Hardbottom Resource
The geographic scope for offshore (>514 m from toe of dune and ~11.5 to 13 m deep) hardbottom epibenthic and fish community resources is the offshore coastal area in the vicinity of developed beaches along the North Carolina coast.

Water Column Resource
The geographic scope for the water column resource is the nearshore and offshore waters in the vicinity of developed beaches along the North Carolina coast.

3. Time Frame

This CEA considers known past, present and RFFP dredge and fill projects that have, may, or will occur in the geographic scopes defined for the resources during a roughly 50 year period. This period was chosen as it covers the initial nourishment of Wrightsville Beach in 1965. Since that time, numerous dredge and fill projects have occurred within the geographic scope of this proposed project. Furthermore, several groins and jetties have been constructed, namely in Oregon Inlet, Beaufort Inlet, and Wrightsville Beach. A CEA time frame extending beyond 2015 is considered immoderately speculative due to indeterminate variables such as future sea level rise, demographics and the availability of suitable nourishment and renourishment material. For the purposes of this analysis, the lengths of beaches nourished along the North Carolina coast were analyzed. In areas where initial nourishment and subsequent renourishments have occurred, the greatest length of beach affected was considered for this CEA.

4. Other Actions Affecting Resources of Concern

Anthropogenic actions affecting resources of concern are hydrodams interrupting supply of sediment to the coast, inlet creation or maintenance, maintenance of navigation

channels, other beach nourishment projects, beach scraping, dune enhancement, placement of hard structures along shoreline, placement of soft structures along shoreline, population increase and associated domestic and industrial activity, commercial and recreational fishing activity, and agricultural activity.

Natural actions affecting resources of concern are hurricanes and sea level rise. The potential for the increase in the rate of damaging storms and hurricanes in light of global climate change has been the source of debate within the scientific community. Recent climate research by the Intergovernmental Panel on Climate Change (IPCC) predicts continued or accelerated global warming for the 21st Century and possibly beyond, which will cause a continued or accelerated rise in global mean sea-level. The historic rate of sea level rise is estimated to be 1.25 ft. per century, however this some projections suggest the rate could double within the next 50 to 100 years (IPCC, 2007). Because only a portion of the observed shoreline change rates are associated with sea level rise, the overall shoreline change rates may be doubled within this time frame. Despite this, Appendix B (Engineering Report) of the FEIS notes that the historic rate of rise in sea level was estimated to cause about 0.5 ft of shoreline recession per year. With measured rates of shoreline change ranging between 2 and 5 ft per year, sea level has very little impact on shoreline change. The minimal impact of increased sea level rise has been noted through the performance of the Wrightsville Beach and Carolina Beach federal storm damage reduction projects. Both of these projects have been in existence since 1965 and have been subjected to the same rate of sea level rise applicable to North Topsail Beach. A review of the nourishment rates for these two projects shows no significant changes in the volume or frequency of periodic nourishment needed to maintain the projects.

5. Resource Response to Change and Capacity to Withstand Stresses

Human Community Resource

Coastal stakeholders (residences and businesses) demonstrate a response to the loss of coastal frontage (beach system) by instituting protection measures which have historically ranged from placement of car frames, tires, concrete rubble, engineered walls, groins, revetments and beach nourishment projects. Very few have demonstrated a willingness to abandon or relocate dwellings or businesses. Coastal visitors/customers will seek out alternative coastal communities having beaches suitable for recreational activity when coastal amenities are not preserved. The capacity of coastal stakeholders to withstand the stresses imposed by eroding shorelines has been increasing in proportion to the stakeholders' affluence.

Beach Resource

The beach system will respond to sediment starvation, sea level rise and the destruction of dune binding vegetation by retreating. The system's capacity to withstand destabilization and erosional stresses is limited to the system's ability to reposition available sediment. Car frames, tires, concrete rubble, engineered walls, groins or revetments do not provide replacement sediment required to mitigate erosional stress.

Beach nourishment increases the beach system's ability to withstand erosional stress through the transfer of sand into the active beach system.

Infaunal Species Resource

Infaunal species inhabit a highly dynamic environment. Infaunal species respond to shoreline erosion and accretion by migrating with shoreline spatial fluctuations. When hard structures (i.e. seawalls, revetments) prevent further shoreline retreat, the infaunal species' habitat is reduced or eliminated. Beach nourishment buries infaunal species, however, research indicates beach nourishment results "in short-term declines in abundance, biomass, and taxa richness" (Burlas, *et al.*, 2001). Infaunal organisms that reside in intertidal zones are more adaptable to fluctuations in their environment, including high sediment transport and turbidity levels (Nelson, 1985). Other studies reported by Maurer (National Research Council, 1995) supported the burial capabilities of nearshore species, which found that these species were capable of burrowing through sand up to 40 cm. Recovery of infauna occurs within 2 to 6.5 months after completion of nourishment projects (Burlas *et al*., 2001).

Shorebird Resource

Shorebirds utilize wetlands, beaches, overwash features, intertidal flats and shoals for breeding, foraging and overwintering. Coastal development and human activity have reduced the availability of these habitat areas. This resource's response has historically been decreasing populations and withdrawal to habitat in less impacted areas such as designated National Seashores and Wildlife Refuges, where development is not permitted.

Sea Turtle Resource

Sea turtle world-wide populations have been declining in response to over-harvesting (eggs and adults), bycatch, ingestion of and/or entanglement with manmade products and pollutant induced disease. As settlement of coastal areas increased, harvesting of nesting turtles and eggs also increased until legislation and education were implemented and a sense of stewardship developed. Placement of coastal protection structures along eroding, developed shorelines reduced or eliminated nesting habitat. Sand nourishment of eroding shorelines has restored nesting habitat along developed coastlines. Considering the relatively low fecundity of these species and their vulnerability to bycatch and manmade products and pollutants, it is probable that even with enhancement and protection of nesting habitat these species will remain threatened.

Intertidal Flats and Shoals Resource

Intertidal flats and shoals are dynamic features. This resource responds to changes imposed by anthropogenic and natural forces by altering composition (volume, grain size, infauna, vegetative cover) and spatial location. Species which utilize this habitat have generally adapted to the natural range of environmental conditions experienced in this habitat. This resource continually seeks to achieve dynamic equilibrium with the natural or man-induced forces affecting it. Dredging within the ebb tide delta and placement of material on North Topsail Beach will result in artificial sand bypassing thereby allowing for the formation of additional flats and shoals.

Salt Marsh Resource

Changes in nutrient loading, current flow, salinity, wave forces, sedimentation, and sea level rise have the capacity to alter the area of distribution and productivity of salt marshes. Historically, coastal development has resulted in the loss of significant areas of salt marsh through burial, channelization and pollution. The response to these stresses has been mortality, reduction of area or succession by exotic or opportunistic vegetative species.

Nearshore Hardbottom Resource

Nearshore hardbottom features are located in a high energy coastal environment and as such can be ephemeral in nature. The species occupying this habitat are generally tolerant of elevated turbidity and wave energy, temperature and salinity fluctuations, and periodic burial. Hardbottom features are naturally resistant to erosion due to their geologic nature. The species attached or associated with this resource have adapted to the wider range of environmental conditions to which they are exposed. Stresses to this resource must exceed the natural temporal range of conditions to which it has adapted in order to adversely affect this resource in the long-term. This resource may not be as resistant to mechanical disturbances (anchors, cables, pipelines, bottom fishing gear).

Offshore Hardbottom Resource

Offshore hardbottom features are generally more persistent and less ephemeral in nature than nearshore hardbottom features. The species attached or associated with this resource have adapted to less extreme environmental conditions than those of nearshore hardbottom habitat. This resource's depth and distance from the shoreline provides a buffer for the short-term environmental fluctuations experienced nearshore. This resource may not be as resistant to excesses of turbidity, sedimentation and mechanical disturbances (anchors, cables, pipelines, bottom fishing gear).

Water Column Resource

The water column resource is a dynamic and complex system; the quality of which is influenced by anthropogenic and natural inputs. In the nearshore and estuarine environments this resource's quality is affected by nutrient loading, suspended sediment, and pollutant inputs. The resource's response to these inputs can be eutrophication, reduced photo-productivity, contamination of the food chain and changes in the life-supporting capacity of the water column. The capacity of the water column to accommodate inputs is related to the rates of flushing, exchange, and mixing.

6. Stresses in Relation to Regulatory Thresholds

The Coastal Barrier Resource System (CBRS) was established in 1982 with the Coastal Barrier Resource Act (CBRA) and modified in 1990 with the Coastal Barrier Improvement Act (CBIA) in order to prevent the Federal Government from taking any action that could ultimately encourage or facilitate development on barrier island segments located within the CBRS. The Acts do not prevent private actions by municipalities or individuals. Coastal areas are considered desirable places to inhabit.

As population continues to increase it is anticipated that the demand for coastal development will increase.

7. Resource Baseline Conditions

Human Community Resource

The human community baseline condition defined for this CEA involves 3,330 km of shoreline along the Atlantic east coast from Maine to south Florida and 2,625 km of shoreline along the Gulf coast from south Florida to Mexico. Since 1923, approximately 680 km (20.4%) of the Atlantic east coast and approximately 211 km (8%) of the Gulf coast of shoreline (total 891 km [15%]) has been nourished at least once (Finkl *et al*., 2006). Along this continuous coastline there is an assortment of undeveloped shorelines set aside for protection and recreation purposes. These include National Seashores (approximately 713 km, Atlantic & Gulf shorelines – About, Inc., 2006)), National and State Wildlife Refuges, military bases, and State and Municipal parks. Development and recreation is prohibited, limited or controlled in these coastal areas. Many of these areas contain federally designated critical habitat utilized by endangered or threatened species.

The project area is considered a developed coastline comprised of dwellings (1,158 housing units) and businesses. No hard shoreline protection structures are present along the coastline of the project area. Limited placement of sand bags (soft shoreline protection structures) has occurred within the project area near the north end of North Topsail Beach.

The Atlantic Intracoastal Waterway (AIWW) was constructed in the early 1930's behind New River Inlet. This action connected the sounds behind Onslow Beach and Topsail Island with sounds to the north and south. In 1940 a navigation channel connecting the AIWW, adjacent sounds, New River, and New River Estuary with the Atlantic Ocean was dredged. The US Army Corps of Engineers (USACE) have repeatedly dredged New River Inlet for navigational purposes since 1964. Between 1964 and 1978 dredged material was sidecast from the channel to a point immediately outside the channel (total ~750,000 cy). From 1978 to 2002 a combination of hopper and sidecast dredges were utilized. The hopper dredge deposited dredged material offshore of the adjacent beach in 10 to 15 feet of water (total ~765,500 cy to 2002), while the sidecast dredge deposited material to a point immediately outside the channel (total ~5,837,000 cy to 2002). Cedar Bush Cut (CBC), a channel connecting the AIWW with New River Inlet has been repeatedly dredged by the USACE since 1976 (total ~1,880,000 cy to 2002). Dredging of the CBC is performed utilizing hydraulic pipeline dredges with disposal of the dredged material normally on the north end of North Topsail Beach (CPE, 2004; CPE, 2006).

Maintenance of the inlet is a necessity for fishermen, recreational boaters and the United States Marine Corps Camp Lejeune Base which utilize New River Inlet as a primary ingress/egress route to the Atlantic Ocean.

Beach Resource

For the purposes of this CEA, the beach consists of those areas occupied by dunes and associated vegetation, dry beach and intertidal beach along the Atlantic East coast and Gulf coast shorelines.

In many developed areas along the Atlantic east coast and Gulf coast shorelines, the stability of dunes and native vegetative cover has been compromised through the building of structures. In some areas dune formations have been destroyed to permit construction of buildings. In other areas, nourishment, renourishment, dune protection and management programs have been implemented for shoreline protection. It is outside the scope of this CEA to quantify the extent these conditions are present along the Atlantic east coast and Gulf coast shorelines. In undeveloped areas where anthropogenic activity is prohibited, limited or controlled, natural dune systems exist in dynamic equilibrium and support various flora and fauna dependent on these systems. Along developed shorelines, management, protection and restoration measures have achieved varying degrees of stability for this resource.

In the northern reach of the project area, approximately 1,880,000 cy of dredge material has been deposited on the north end of North Topsail Beach since 1976. In the northern reach of the project area, limited or no dune protection measures have been implemented; destabilized, unvegetated sand has migrated landward, and in some situations, beneath and behind existing structures.

Seabeach amaranth (*Amaranthus pumilus*), a Federal and State threatened species, is a 'fugitive' species which grows on barrier island beaches in recently disturbed by storms or beach nourishment. It prefers overwash flats at accreting ends of islands and lower foredunes and upper strands of noneroding beaches; these preferred habitats are located on both sides of the New River Inlet. It does not compete well with other dune vegetation which supports a positive association with beach nourishment projects. (NCFWS, 2006; Nash, 2002). In the central and southern reaches of the project area the dune system is moderately vegetated and marginally stable.

There are 55 known plant populations, of which 34 are found within North Carolina with the remaining smaller plant populations outside of North Carolina. North Carolina is considered to be the only State to have large populations of seabeach amaranth and although the North Carolina populations reached historic lows in 2000 (Jolls *et al*., 2003), the Endangered Species Bulletin (Randall, 2002) reported that the numbers of seabeach amaranth are increasing.

Seabeach amaranth is frequently found in large numbers on Onslow Beach, as seen between July 15 and August 15, 2004, 1,797 individual plants were observed there; 1,670 of those plants (93% of the 2004 population) were found at the extreme south-end of Onslow Beach (within the project area). New River Inlet and the overwash flat consistently harbor the majority of the seabeach amaranth population on Onslow Beach (S. Brewer, pers. comm.).

Infauna Resource

Multiple assessments of infaunal abundance, biomass and taxa richness from Maine to Florida suggest that infaunal abundance will be similar to that reported from other Atlantic coast beaches (Burlas *et al*., 2001). On oceanfront beaches, most benthic organisms in the intertidal zone consist of infaunal burrowing forms, particularly polychaete worms (Phylum ANNELIDA), coquina clams (*Donax variabilis*) and mole crabs (*Emerita talpoida*) (USFWS, 2002).

While several species of amphipods and polychaetes populate the intertidal and shallow subtidal beaches of North Carolina, their contribution to the total biomass of benthic infauna is low due to their small body size. Therefore, mole crabs and coquina clams dominate the benthic infaunal community due to their biomass (Peterson *et al.*, 2000).

Baseline data depicting the infaunal species populations occurring within the specific project area is unavailable; however the information regarding pre-construction and post-construction monitoring at Bogue Inlet is applicable. Prior to the relocation of the channel within Bogue Inlet, infaunal species were dominated by various worms, crustaceans, snails, intertidal insects, and bivalves. Overall, the species richness and abundance increased during post-construction sampling events. Results showed that natural disturbances in the area may have equaled project related effects as the inlet environment remains dominated by physical stress (Carter, 2008).

Shorebird Resource

For the purposes of this CEA the baseline conditions for shorebirds will be described by species.

Roseate Tern (*Sterna dougallii dougallii*)

The roseate tern (*Sterna dougallii dougallii*) is federally listed as endangered along the Atlantic coast south to North Carolina. It is listed as threatened in Florida, Puerto Rico and the U.S. Virgin Islands. It is globally ranked G4 considered as apparently secure globally throughout its range (NCNHP, 2006). In 1998 the world population was estimated at approximately 40,000 pairs, and the northeastern population at around 3,500 pairs (USFWS, 2004). The species is reported as having no breeding areas in North Carolina, but is an occasional visitor to the Cape Hatteras National Seashore during July and August and may pass through the coast of North Carolina from March to May and August to October en route to their breeding grounds (New York to Nova Scotia) or wintering grounds (South America), respectively (NCDPR, 2006). The species has not been reported within the project area (USFWS, 2006).

Piping Plover (*Charadrius melodus*)

The piping plover (*Charadrius melodus*) Atlantic coast population is federally listed as threatened with a population estimated at less than 1400 pairs (USFWS, 2004). This species is ranked globally as G3, considered rare throughout its range (NCNHP, 2006) and listed as threatened throughout their wintering range (USFWS, 1996). Critical Habitat areas for Wintering Piping Plovers include

areas of Dare and Hyde Counties within the Cape Hatteras National Seashore (USFWS, 2006). There are no Critical Habitat areas designated within the project area.

Until 1918, when the Migratory Bird Treaty Act was implemented, hunters were considered to be the primary cause for the population decline in all three geographic breeding regions (Atlantic Coast population, Northern Great Plains population, Great Lakes population) during the 19th and early 20th centuries. From the 1940's until now, habitat loss, increased predation and disturbance from humans and pets has continued to be cited as major contributing factors for the decline of the Atlantic Coast population (USFWS, 1996).

The loss of Atlantic Coast habitat has largely been attributed to the development of permanent structures, which alters natural beach processes and prevents natural overwash events. Structures that have been identified as having significant effect on nesting habitat include seawalls, jetties, piers, homes, parking lots, and other interfering structures. Animal and human disturbances, depending upon duration and proximity of perceived threat, may result in adults leaving eggs or chicks exposed to predators or inclement weather and may result in disruption of nesting, foraging, and roosting behaviors.

Adult mortality has been identified as a key determinant in population trends, while nest sites and clutch size were not found to cause early populations to decline (Burger, 1987; 1991). Juvenile mortality may not have as strong of an effect on populations as adult mortality; however reproductive success is lower in areas with high human disturbance (Burger, 1987; 1991). While piping plovers illustrate acclimation to human disturbances via flexible habitat use (i.e., the ability to forage in a different habitat e.g. backbay or ocean) abandonment of native habitats often results (Burger, 1994).

The loss of bird migration habitats in the coastal zone has been extensive. Habitat and shoreline armoring, along with the disturbance from humans and pets have reduced intertidal habitats used by piping plovers and other shorebirds for foraging, roosting and nesting.

The southern subpopulation of the U.S. Atlantic Coast Population includes Delaware, Maryland, Virginia, South Carolina and North Carolina. The North Carolina coastline is important to piping plovers since it provides habitat for wintering, breeding, and migration. In 1996, the USFWS (2006g) counted 1,348 breeding pairs in the Atlantic Coast population. In 2001, U.S. breeding pair populations showed a 10% gain with a total pair count of 1,280, while the total U.S. Atlantic Coast population had increased by 13% to 1,525 breeding pairs (USFWS, 2007b). The 2002 Atlantic Coast population had 1,690 nesting pairs of piping plovers, while nesting pairs in North Carolina totaled 23 (USFWS, 2007b). These numbers were comparable to the 2000 to 2001 Annual Status Update for the U.S. Atlantic Coast Piping Plover Population (USFWS, 2002a). In 2003, the

USFWS (2007b) reported 1,676 nesting pairs in the Atlantic Coast population, with 24 nesting pairs reported in North Carolina. Preliminary nesting pair estimates for the Atlantic Coast population as reported to the USFWS are: 1,660 in 2004, 1,632 in 2005, and 1,743 in 2006 (USFWS 2007; 2007a; 2007c). The 2006 preliminary abundance estimate illustrates a 29% increase from 1996 to 2006 in the number of breeding pairs of the Atlantic Coast population.

The North Carolina breeding population experienced a decline in the number of piping plover breeding pairs decreasing from 55 pairs in 1989 to 24 pairs in 2003 (USFWS, 2006a). However, preliminary estimates indicate a slight increase in breeding pairs to 37 in 2005 and to 46 pairs in 2006 (USFWS, 2007; 2007a). This continuing low productivity leaves North Carolina vulnerable to problems associated with very small, sparsely distributed populations (e.g., difficulties finding mates) (USFWS, 2004).

Non-breeding Piping Plovers have been observed utilizing the New River Inlet area during migration and over winter. Based on survey data conducted by the NCWRC since 1989 (annual nesting habitat surveys, coast-wide wintering surveys, limited opportunistic surveys, and pre-construction monitoring) a total of 48 Piping Plovers have been identified within the project vicinity. Surveys conducted on Onslow Beach by U.S. Marine Corps personnel observed 171 Piping Plovers between 1996 and 2009 (S. Cameron, pers. comm.; C. Tenbrink, pers. comm.). Additionally, a total of thirty-seven (37) non-breeding Piping Plovers were observed within proximity to the New River Inlet over the course of pre-construction surveys. No nests have been documented on Onslow Beach between 1996 and 2008 (S. Brewer, pers. comm.; S. Cameron, pers. comm.); however, a single Piping Plover nest was observed on Onslow Beach in 2009 in which the nest hatched on July 5, 2009 (K. Ray, pers. comm.).

Wilson's Plover (*Charadrius wilsonia*)

The Wilson's plover (*Charadrius wilsonia*) is designated by the State of North Carolina as Significantly Rare. This is a peripheral species (North Carolina lies at the periphery of this species range) requiring monitoring by the North Carolina Natural Heritage Program. There is no federal status for this species, and it is considered globally secure (G5 rank) (NCNHP, 2006). Wilson's plover breed in eastern and southern coastal areas of the United States and overwinter along the Florida Atlantic coast and Gulf coasts to northern South America (GAMNH, 2000). During the period from 1989 to 2004, the number of Wilson's plovers recorded in or near the proposed project area (New River Inlet, Onslow and Topsail Beaches) ranged from 2 to 15 individuals and 0 to 7 breeding pairs (Cameron, 2005). During pre-construction monitoring, a total of 18 nesting pairs were observed within this area along with one nest.

The gull-billed tern (*Sterna nilotica*) is designated by the State of North Carolina as threatened. There is no federal status for this species, and it is considered

globally secure (G5 rank). This species' status in Onslow County is listed as historical (not observed during the last 20 to 50 years) (NCNHP, 2006).

The least tern (*Sterna antillarum*), common tern (*Sterna hirundo*) and black skimmer (*Rynchops niger*) are designated by the State of North Carolina as Special Concern (species which are determined by the Wildlife Resources Commission to require monitoring). There is no federal status for these species. The common tern and black skimmer species are considered globally secure (G5 rank), while the least tern is ranked as apparently globally secure (G4 rank). These species' status is considered current (observed within the last 20 years) in Onslow County (NCNHP, 2006). These species have been observed in or near the project area during the May-June breeding period from 1977 through 2004 (Cameron, 2005). During pre-construction monitoring, a total of 37 nesting pairs were observed within this area along with 36 nests.

Sea Turtle Resource

The leatherback (*Demochelys coriacea*) is listed on the Federal Register as endangered. "The loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) turtles are listed as threatened, except for breeding population of green turtles in Florida and on the Pacific coast of Mexico, which are listed as endangered." (EPA, 2003). All three species are listed as endangered by the International Union of Conservation of Nature and Natural Resources, with the leatherback being critically endangered. The estimated world population of nesting leatherbacks is 35,860; nesting loggerheads is 44,560; and nesting greens is 88,520 (CCC, 2003). The 2005 sea turtle nesting data indicates that along the entire North Carolina shoreline there were 647 loggerhead nests, 16 green nests and 9 leatherback nests (Godfrey, pers. comm.). Between 2001 and 2008, a total of 366 loggerhead sea turtle nests were observed along North Topsail Beach. During this same time period, only one green sea turtle nest was observed (Godfrey, pers. comm.).

Intertidal Flats and Shoals Resource

Along developed and undeveloped Atlantic and Gulf coast beaches adjacent to inlets, this resource changes spatially and temporally in response to forcing functions (tide, current, and weather conditions). In developed areas this resource is influenced by anthropogenic activities (dredging and training). The New River Inlet ebb tide delta is estimated to be 5.8 times larger than its pre-1938 unaltered state before the channelization of Cedar Bush Cut. Dredging of Cedar Bush Cut increased the tidal prism by a factor of five and connected the Atlantic Ocean with the AIWW and coastal sounds. Cedar Bush Cut and New River Inlet have been maintained since the 1940's by periodic dredging (CPE, 2004). The project area contains approximately 130 acres of tidal shoals.

Salt Marsh Resource

In eastern North Carolina, salt marsh communities can be found along 4,500 miles of coastal shoreline, which encompasses 2.1 million acres of estuarine habitat (NCCF, 2007). There are four kinds of coastal marsh habitats: low marsh, high marsh, brackish marsh, and freshwater marshes.

Approximately 72 acres of salt marsh exists within the project area on the sound side (backbarrier marsh) of North Topsail Beach and along the inlet shoreline of Onslow Beach. Approximately 51 acres of marsh exists on the sound side of North Topsail Beach and approximately 21 acres has been identified to the east of the New River Inlet behind Onslow beach. In total, these areas comprise 64 acres of low marsh and eight acres of high salt marsh. The acreage of both low and high marsh habitats has been estimated by remote analysis of the 2005 and 2006 aerial photographs.

The shellfish industry is a large economic industry for North Carolina coastal areas. Three species of shellfish found in coastal waters include eastern oysters (*Crassostrea virginicus*), hard clams (*Mercenaria mercenaria*), and bay scallops (*Argopecten irradians concentricus*).

The structures that are created by shellfish create, such as beds and reefs, are used by many species of fish and invertebrates (Burrel, 1986). The South Atlantic Fishery Management Council (SAFMC) defines this habitat as "the natural structures found between (intertidal) and beneath (subtidal) tide lines, that are composed of oyster shell, live oysters and other organisms that are discrete, contiguous and clearly distinguishable from scattered oysters in marshes and mudflats, and from wave-formed shell windrows" (SAFMC, 1998). Common terms used to describe shell bottom habitats in North Carolina are "oyster beds," "oyster rocks," "oyster reefs," "oyster bars," and "shell hash." Shell hash is a mixture of sand or mud with gravel and/or unconsolidated broken shell (clam, oyster, scallop, and/or other shellfish).

Extensive intertidal oyster rocks occur in North Carolina's southern estuaries, where the lunar tidal ranges are higher. The New River is a good example of shell hash habitat (Street *et al*., 2005). The SAFMC has designated oyster reefs as Essential Fish Habitat (EFH) for red drum (NMFS, 1999).

The North Carolina Division of Marine Fisheries (NCDMF) Shellfish Mapping Program has mapped the general location of shellfish habitats, and have identified strata W (intertidal hard, non-vegetated, with shell) and strata V (intertidal hard, vegetated without shell) in and around the New River Inlet where oysters and hard clams can be found (Caroon, pers. comm.; Conrad, pers. comm.). Shell bottom is found in parts of Stump and Topsail Sounds, from Cedar Point east along the AIWW and in parts of the New River. No shell bottom habitat was found in Cedar Bush Cut, the New River Inlet or the North Topsail Beach Shoreline in the 'General Location of Mapped Fish Habitats in Coastal North Carolina' (Street *et al*., 2005).

Benthic habitat surveys were conducted by the NCDMF in 1991 and 1992 (Conrad, pers. comm.). The surveys included identifying number of bushels of hard clams (*Mercenaria mercenaria*), oysters (*Crassostrea virginica*), and bay scallops (*Argopecten irradians*) present. While the 1992 data does not confirm the absence of shellfish in the project area, it does confirm that none were found at the time of sampling and that most of the project area is absent of potential shellfish habitat.

Habitat likely to support three species of penaeid shrimp (white (*Penaeus setiferus*), pink (*P. duorarum*) and brown (*P. aztecus*)) includes muddy marine bottoms, creek and river bottoms, and grassbeds. Although the population size of penaeid shrimp is unknown, habitat supporting white, brown and pink shrimp is likely to occur in the project area.

Review of penaeid shrimp abundance in the New River Estuary reported in the Estuarine Living Marine Resources (ELMR) database indicates that brown shrimp larvae are likely to be common during November, December and January and abundant from February to April. Juvenile brown shrimp are reported as rare in November and absent from December through March. Adult brown shrimp are reported as not present in the estuary at any time during the year. Larval pink shrimp are reported as common in November only. Juvenile pink shrimp are reported as common from November through April. Adult pink shrimp are reported as not present in the estuary at any time during the year. Larval white shrimp are reported as not present during November through April. Juvenile white shrimp are reported as abundant in November, decreasing to common in December and not present from January through April. Adult white shrimp are reported as not present in the estuary at any time during the year (NOAA, 2005).

Penaeid shrimp stocks in North Carolina are considered viable. High fecundity and migratory behavior permit penaeid shrimp to rebound from very low population size in one year to a large population size in the next (NCDMF, 2005).

Research indicates that "juvenile blue crabs have wide distributions, but they are most abundant in middle and upper estuarine waters of low to intermediate salinity. Optimum sediment for small crabs is detritus, mud, or mud-shell bottom. Subtidal sand and mud bottoms have been documented as overwintering habitat for juvenile blue crabs. Small creeks and rivers in and around salt marshes provide shallow-water habitats for larger juveniles and mature crabs for feeding and refuge during molting." (NCDMF, 2004). The blue crab fishery is North Carolina's most valuable commercial fishery (NCDMF, 2005).

Studies of blue crabs have shown that seagrass beds can be important as settlement, nursery and over-wintering habitat. "Much scientific evidence points to the importance of SAV in the blue crab life cycle. Growth of young crabs is faster in SAV; the survival of juvenile crabs is higher; the densities of crabs are substantially higher; and the abundance of juvenile crabs is higher." (NCDMF, 2004). The NCDMF (2004) reports that seagrasses become seasonal south of Bogue Sound to New River. The report states that "*Zostera* may form separate small patches in the cold months, but may be absent from some areas during warm winters as well as during late spring-fall. *Halodule*, uncommon in this area, forms small, widely spaced, isolated patches in summer in only a few locations. South of the New River area, seagrasses are not an important habitat, being absent entirely or present as isolated seedlings only during late winter." (NCDMF, 2004).

Reduced landings of the blue crab in North Carolina during the 2000 to 2002 and 2004 to 2005 seasons has resulted in a NCDMF stock status rating of concern (NCDMF, 2006).

Overfishing, estuarine habitat loss, and water quality degradation are major factors in sustaining stocks of this species (NCDMF, 2004).

Nearshore Hardbottom Resource

This resource is temporally and spatially transitional along coastal shorelines as a result of its position within the active sand sharing system. Diabathic (onshore-offshore) and parabathic (longshore) sand transport cause this resource to be ephemeral (exposed and/or buried) in response to short and long-term sea conditions. This resource is also affected by deposition of finer suspended sediments (silt, clay) derived from land-based sources. Therefore it is difficult, if not impossible, to establish accurate spatial and temporal base-line conditions for the overall resource. As shorelines recede in response to sea level rise and coastal sediment starvation from damming of rivers and coastal modification, there is the potential for additional hardbottom exposure as well as burial (Bruun Rule[1]) of deeper nearshore hardbottom. The species associated with nearshore hardbottom have adapted to this high energy, ephemeral environment. Epibenthic and fish communities for nearshore hardbottom (approximately 260,537 sq m) resources in the project area were observed by CPE marine biologists during underwater investigations in June, August and October 2005 and August 2006.

Offshore Hardbottom Resource

Approximately 1,652,857 sq m of offshore hardbottom habitat has been identified in the project area. This resource is generally less ephemeral than the nearshore hardbottom resource; normally supporting greater diversity and density of associated species. Although this resource is outside the active sand sharing system, it is susceptible to sedimentation from more highly transportable silts and clays. In general the resource presents a more stable environment than nearshore hardbottom, however, the resource is affected by extreme storm events such as hurricanes and floods.

CPE marine biologists confirmed offshore hardbottom at two locations in June 2005 which were covered by > 60 cm of mud in October 2005 (CPE, 2006) following direct impact from Hurricane Ophelia (11-14 September) (NOAA, 2006) and peripheral effects associated with other hurricanes during that season.

Water Column Resource

The quality of the water column resource is related to the presence or absence of inputs (anthropogenic or natural). Inputs to nearshore and offshore waters enter the water column through inlets and oceanic currents. Within the project area, the tannin enriched (blackwater) New River waters (Mallin *et al*., 2000) are recognized as eutrophic (Mallin *et al*., 2005) and classified as Nutrient Sensitive Waters (Street *et al*., 2005). The nearshore water column in the vicinity of the project area experiences high turbidity and high light attenuation due to the natural background levels of these inputs.

[1] "…the offshore bottom for any rise in sea level will undergo a gradual adjustment process tending to keep its "equilibrium form." By this process, the bottom may be raised together with the sea level until it is covered by the same depth of water at the same distance from the (new) shoreline as it was before the rise. The material needed to raise the bottom is assumed to come from the corresponding shore area by movement of material by transversal (rip) currents and by diffusion currents." (Bruun, 1962).

8. Identification of Important Cause and Effect Relationships

The proposed action is a shoreline protection project. The proposed project is scheduled for winter construction. It incorporates shoreline stabilization and beach nourishment utilizing ebb tide delta and offshore sand sources. Flowcharts describing the cause and effect relationships between the proposed project activities and resources are depicted in Appendix 1.

Human Community Resource

This and similar nourishment projects, which have occurred since 1923, and those which are scheduled to occur in the reasonable foreseeable future, facilitate the occupation and development of the coastal shoreline while reducing the perceived or real need for hard coastal protection structures. The increasing demand for coastal dwellings and recreation areas by the migration and increase in the human population is and will continue to impose additional stresses on the coastal ecosystem. Private, local, state and federal infrastructure (roads and bridges, cabins, toilets, ferrys, etc.) is in place to facilitate access to and use of the coastal environment.

Beach Resource

The proposed project will cause the sandy beach to be widened seaward of existing structures. This and similar projects compensate for retreat of the shoreline as a result of sea level rise and sediment starvation. This project has the potential to create suitable habitat for dune vegetation and provide shoreline protection. The increased beach width will provide additional habitat for seabeach amaranth and nesting sea turtles.

Infaunal Species Resource

The proposed project will result in the initial mortality of infaunal species in the nourishment sites within the project area due to direct burial of species at the fill placement area. The proposed project will disturb benthic habitat (offshore borrow area), an area of potentially utilized by penaeid shrimp and other commercially important species which forage upon infaunal resources.

Shorebird Resource

In the long-term, the proposed project has the potential to enhance nesting habitat for some bird species while degrading habitat for species unable to adapt to disturbances associated with human presence.

Sea Turtle Resource

The proposed project will widen the beach seaward of existing structures increasing the area available for nesting activity. Sediment compatibility standards, wintertime dredging, and other minimization and avoidance measures will reduce impacts to sea turtle resources. A cutterhead dredge will be utilized for the proposed dredging activity. Although no sea turtle takes have been reported with the use of a cutterhead dredge, the risk for potential takes remains.

Intertidal Flats and Shoals Resource

The proposed project will remove a portion of the ebb tide delta (tidal flat/shoal) through dredging causing a reduction in area of this habitat as well as shifting of shoals as the channel equilibrates. However, the ebb tide delta is expected to reform during the four year interval between channel realignment.

Salt Marsh Resource

The proposed project is not expected to affect this habitat due to the resources' inshore location and distance from dredging activity.

Nearshore Hardbottom Resource

The proposed project will place additional volumes of sand in the active sand sharing system. During construction and as the shoreline adjusts to a new equilibrium there is the potential for increased sediment deposition on this resource.

Offshore Hardbottom Resource

The proposed beach nourishment is not expected to affect this resource as it is located outside the active sand sharing system. The dredging activity within the borrow area is not expected to have an effect on this resource.

Water Column Resource

The proposed project will temporarily elevate turbidity levels in the immediate vicinity of fill placement and dredging activity during construction. Elevated turbidity levels could potentially lead to the clogging of fish gills. Furthermore, elevated turbidity increases light attenuation and therefore may lead to the death of light-dependent submerged aquatic vegetation (SAV).

9. Determine the Magnitude and Significance of Cumulative Effects

This section describes a qualitative assessment of factors associated with positive, negative or neutral (not discernable) effects related to the resource. These findings are summarized in tablature form in Appendix 2.

Human Community Resource

The proposed project as well as past and future nourishment/renourishment projects facilitates continuing human occupation (dwelling, recreation and development) of coastal areas and this is considered to be beneficial to the human community. The environmental consequences of continuing human occupation and development of the coastline are considered to be the most significant negative cumulative effect associated with past, present and future coastal activities. This results from the cumulative effects associated with the pollution, disturbance and/or displacement of other resources. When research, education, and stewardship are encouraged and supported, cumulative effects upon resources can become neutral to positive. The magnitude and significance of the environmental consequences associated with the proposed project are considered to be positive with regard to the human community resource.

The implementation of this proposed project is not anticipated to result in intensified development and redevelopment within the FEMA high velocity wind and high flood hazard zones, nor would it increase the demand for supporting infrastructure. The vast majority of the areas within the CBRA system along North Topsail Beach have been developed without federal assistance or federal flood insurance. Therefore, the inclusion of these areas in the CBRA has had little to no impact on the rate and/or density of development. Following the impacts of Hurricane Fran in 1996 and Hurricane Floyd in 1999, development within the CBRA zone continues.

Beach Resource

The cumulative effect of past, present and future sand nourishment/renourishment projects is the replacement of sand lost from the active sand sharing system as a result of natural and anthropogenic processes. Adding sand to this system enhances this resource's ability to sustain itself and other associated resources. These other resources include the human community, infaunal species, nesting sea turtles, shorebirds, threatened seabeach amaranth (*Amaranthus pumilus*) and other dune vegetation. These species must be adaptable to the presence of the human community in order to benefit from a nourished/renourished beach. The human community must be aware of and willing to accommodate the habitat requirements of these resources. The cumulative effects of beach nourishment projects are maintaining and sustaining the beach resource, creating additional area of dry beach habitat, creating the potential for dune vegetation habitat and sustaining wet beach habitat. The magnitude and significance of the environmental consequences of the proposed project are considered to be positive.

Infaunal Species Resource

The cumulative effect of past, present and future beach nourishment projects is a short-term, negative, direct impact resulting in the mortality of those infaunal species not adapted to avoidance of burial at the fill site and entrainment from the borrow area resulting from dredging operations. Research indicates that infaunal species populations recover within 2 to 6.5 months after completion of nourishment projects. Recovery rate is influenced by temporal and spatial recruitment parameters such as distance to adjacent populations and season of project activity (Burlas *et al.*, 2001). Nelson (1985) indicates that organisms that reside in intertidal zones are more adaptable to fluctuations in their environment, including high sediment transport and turbidity levels. This supports the observation that some organisms withstand burial up to 10 cm (3.9 in). Other studies reported by Maurer (NRC, 1995) supported the burial tolerance of nearshore species, which found that these species are capable of burrowing through sand up to 40 cm (15.8 in). Although the wet beach infauna can adapt to fluctuations in the natural environment, the addition of sediment to the wet beach would have immediate, short-term negative impacts. Rakocinski *et al.* (1996) found that the mole crab population density exhibited a pattern of initial depression after sedimentation but fully recovered in less than one (1) year after beach nourishment.

Historically since 1955, approximately 55.5 miles (17.5%) of North Carolina's entire shoreline (approximately 971 miles) has experienced nourishment activity at least once (Finkl *et al.*, 2006 data set). Recent projects (2002 to 2005) have nourished/renourished

approximately 20 miles (~6%) of shoreline. This includes the relocation of Mason's Inlet (2002) and the inlet channel within Bogue Inlet (2005). Furthermore, relevant activities such as inlet maintenance by the US Army Corps of Engineers has occurred within numerous inlets including Shallotte Inlet, Lockwood Folly Inlet, Cape Fear River, Carolina Beach Inlet, New Topsail Beach Inlet, New River Inlet, Beaufort Inlet, and Oregon Inlet. The vast majority of beach nourishment and inlet maintenance activities have occurred from the proximity of the South Carolina/North Carolina border to Cape Lookout. Present and reasonable foreseeable future projects will involve approximately 41 miles (~12.9%) of the shoreline (Sugg, pers. comm.). The spatial and temporal separation of these projects (Refer to Table 1) can be expected to permit recovery of beach and borrow area infaunal species. Accordingly, the magnitude and significance of the environmental consequences of the proposed 11.1 mile beach nourishment project are considered to be negative (short-term) and neutral (long-term). The phased approach of this project will allow for the recovery of these resources as renourishment along any given stretch of beach will be temporally spaced apart by several years, as depicted in Table 2. It is highly unlikely that the time frame between maintenance events would narrow even in light of unexpected shoreline changes as these nourishment activities are costly and must be budgeted for accordingly.

Table 1
Approximate Length of Past and RFF Projects and Proximity to Project area

Project	Approximate Shoreline Length	Approximate Occurrence of Project	Approximate Distance to Project area
Brandt Island Pump-out	4.3 miles	November 2004 – February 2005	40 miles north
Inner Harbor Maintenance – Morehead City Federal Navigation Project	2,000 ft	January – April 30 2007	40 miles north
Pine Knoll Shores – AIWW Section 1	2,000 ft	January – March 2008	31 miles north
Cape Lookout National Seashore east side of Cape Lookout Lighthouse	0.5 miles	Winter 2005/2006	90 miles north
Beaufort Inlet Dredging/ Section 933 Project Placement of material on Indian Beach, Salter Path, and portions of Pine Knoll Shores	7 miles	February - March 2004 and January – March 2007	Dredging and Placement 40 miles to the north
Emerald Isle FEMA Renourishment Project	3.8 miles	March 2007	23 miles north
Bogue Inlet Channel Relocation Project	4.0 miles	March 2005	20 miles north

Carteret County Bogue Banks Beach Restoration Project	25 miles	2008 – 2012	20 miles north
Bogue Inlet Maintenance Dredging	0.66 miles	2006	20 miles north
New River Inlet Dredging, North Topsail Beach Nourishment	11.1 miles	Maintenance dredging every four years	0 miles
Town of Topsail Beach, Federal Project	4.5 miles	2012	22 miles
Figure Eight Island, North & South sections	2.5 miles	Winter 2005/2006 and proposed 2010	30 miles south
Wrightsville Beach	2.84	Winter 2004/2005 and proposed 2011	35 miles south
Wrightsville Beach & Mason's Inlet Relocation Project	1 mile	Winter 2002	35 miles south
Wilmington Harbor Deepening (Section 933 Project)	1.99 miles	Dec. 2001 – Feb 2002	40 miles south
Carolina Beach	2 miles	Dec. 2006- Feb. 2007 and proposed 2010	45 miles south
Kure Beach	2 miles	Dec. 2006- Feb. 2007 and proposed 2010	50 miles south
Bald Head Island	0.34 miles	Winter 2005/2006 and 2009	60 miles south
Holden Beach - East	1.9 miles	March-April 2002	75 miles south
Holden Beach – East & West	1.5 miles	March-April 2002 and Dec 2003 – April 2004	75 miles south
Holden Beach - East & West	2.7 miles	2006	75 miles south
Ocean Isle Beach	2 miles	Winter 2006/2007 and proposed 2011	85 miles south
Topsail Beach Banks Channel Disposal Project	.76 miles	October 2007	22 miles

(Sugg, pers. comm.)

Table 2
Phased nourishment activities

Phase	Years	Baseline Stations	Fill Length (ft)	Volume (cy)	Re-Nourishment (Phase)*	Re-Nourishment Volume (cy)
1	2010-11	1070+00-1160+00	9,000	544,400	NA	NA
2	2012-13	968+80-1070+00	10,120	940,700	NA	NA
3	2014-15	785+00-900+00	11,500	393,800	Phase 1	233,200
4	2016-17	900+00-968+80	6,880	721,500	Phase 2	121,800
5	2018-19	581+80-785+00	20,320	512,400	Phases 1-3[1]	627,000

Shorebird Resource

The cumulative effect of beach nourishment projects on these resources is related to the species' ability to adapt to displacement or avoid disturbance associated with developed shorelines. All shorebirds considered for the purpose of this CEA, with the exception of the piping plover, are globally ranked as G4 (apparently globally secure) or G5 (globally secure). The roseate tern has been reported to be an occasional visitor to the Cape Hatteras National Seashore in the summer, and has not been reported within the project area (USFWS, 2006).

In 2006, approximately 46 piping plovers are breeding in North Carolina with approximately 84 birds overwintering with no data indicating the recent presence of overwintering or breeding piping plovers in the project area. Non-breeding piping plovers have been observed utilizing the New River Inlet area during migration and winter, although they have not been observed breeding there for about twelve years (Cameron, pers. comm.). This finding does not indicate that piping plovers do not utilize New River Inlet habitats for breeding but may be due to lack of survey resources.

The Wilson's plover is designated by the State of North Carolina as Significantly Rare. It appears likely that the Wilson's plovers' rarity is due more to the fact that North Carolina is on the periphery of the species' range, rather than a result of anthropogenic influences. It is ranked G5, globally secure throughout its geographic range.

The gull-billed tern, although ranked G5, is considered threatened in North Carolina. Gull-billed terns have been observed within Onslow County, although occurrences are considered to be rare. A breeding pair was observed in 1988 and non-breeding individuals have sporadically been observed since. The least tern, common tern and black skimmer are listed as species of Special Concern within the State of North Carolina, requiring monitoring. They are considered current in Onslow County. The Global rankings are G4 (least tern) and G5 (common tern and black skimmer) (NCNHP, 2006).

The limited populations of the above shorebirds is likely attributable to being on the periphery of their global range or an inability to adapt to habitat displacement and disturbance associated with coastal development. The cumulative effect of past, present and future beach nourishment projects and inlet realignment/relocation projects will likely be to facilitate the potential for continued disturbance of the coastline because it sustains the shorelines capacity to support existing and continued development. The magnitude and significance of environmental consequences of the proposed project and similar activities occurring throughout the geographic scope of these species are considered to be negative.

The maintenance of the New River Inlet in a fixed position is not expected to impact the inlet dunes and beaches, an important shorebird resting and nesting habitat. New River Inlet has not experienced any substantial wholesale migration or gross change in position over the last 50 years. For the most part, the inlet fluctuates north and south within a fairly small corridor. The major impacts the inlet has on the adjacent shorelines is associated with the instability of the ocean bar channel which tends to go through cycles with the channel migrating from a southwesterly alignment to one with a more southeasterly component. These shifts in the inlet channel produce episodes in which ocean bar sediments migrate on shore as the ocean bar channel migrates and abandons previous portions of the ebb tide delta.

In the absence of artificial beach nourishment, as would be the case for Onslow Beach, the south end of the island will continue to experience frequent episodes of overwash which provide nesting habitat for a number of bird species. Overwash events along North Topsail Beach, however, would be minimized due to the protection provided by beach fill.

The Bogue Inlet Channel Relocation Response Project, which was constructed in 2005, served to relocate the main inlet channel within Bogue Inlet approximately 3,500 feet. A bird monitoring project was implemented prior to construction and was continued following construction in order to assess project related impacts to bird resources. The most abundant species in Bogue Inlet were Laughing Gull (*Larus atricilla)*, Royal Tern (*Sterna maxima)*, Black Skimmer *(Rynchops niger)*, Herring Gull *(Larus argentatus)*, and Brown Pelican (*Pelecanus occidentalis*). These species totaled 56.6% of the waterbird observations from all monitoring activities (pre-construction and post-construction). The average number of all waterbird species were higher for each season during pre-construction surveys in 2003/04. The average number of waterbirds using the inlet during spring migration was relatively consistent from 2005-2008 and varied each year during fall migration and winter months. In general, the highest numbers of waterbirds were observed during fall migration. Similar results would be anticipated following the implementation of this proposed project.

Mollusk and Crustacean Resource

Penaeid shrimp and blue crab habitat requirements preclude significant populations from being present in the project area during winter construction. These species have adapted

to relatively high turbidity conditions, with the ability to forage and overwinter in mud. Therefore, the temporary elevation of turbidity associated with past, present and future nourishment projects that have been and will be temporally and spatially separated, is not expected to have significant cumulative effects on these species. The magnitude and significance of the environmental consequences associated with the proposed project are considered to be neutral.

The shellfish habitats mapped by the NCDMF are located in the Atlantic Intracoastal Waterway (AIWW), Stump Sound and lower reaches of the New River Estuary. The habitat area in the AIWW is approximately 12,000 feet inland from the proposed New River Inlet relocation and approximately 4,000 feet outside the project area. The Stump Sound habitat is approximately 6,000 feet from the proposed New River Inlet relocation and approximately 1,000 feet outside the project area. The lower reaches of the New River Estuary habitat area are beyond the AIWW habitat area. The Stump Sound habitat area is sheltered from the project area by salt marsh and upland hammock. The AIWW and lower reaches of the estuarine habitat areas are sufficiently distant from the project area so as not to be affected by dredging activities. The use of a cutterhead suction dredge to transfer material from the low silt content of New River Inlet ebb tide delta is not expected to increase turbidity levels above the natural range of ambient levels experienced by organisms utilizing this habitat. The magnitude and significance of the environmental consequences associated with the proposed project are considered to be neutral.

Sea Turtle Resource

The proposed project, as well as past and future nourishment/renourishment projects, has the cumulative effect of countering the erosive effects of sea level rise and anthropogenic influences by widening beaches. Beaches where width is maintained or widened appear to facilitate turtle nesting. Nesting data trends reported by the Fish and Wildlife Research Institute for Florida indicate "Regression of log-transformed nest numbers show no trend in annual loggerhead nesting ($r = 0.41$)" for the period 1989 to 2005. "A regression of log-transformed nesting in combined two-year groups 1990 to 2005 reveals a significant upward nesting trend ($r = 0.97$)" for green turtle nests. "A regression of log-transformed nest numbers reveals a significant increase in leatherback nesting over the 17 years period ($r = 0.92$)" for the period 1989 to 2005 (FWRI, 2006). Preceding and during this period, Florida, where significant turtle nesting occurs, has constructed the greatest number and length of beach nourishment/renourishment projects along the Atlantic east coast and Gulf coast shorelines (Finkl *et al*., 2006 data set). Review of available 2005 nesting data for Florida, Georgia, South Carolina and North Carolina reveals that the total number of nests for *C. caretta* was approximately 57,788 (FWRI, 2006; CRP, 2005; SCDNR, 2006; MacAllister, 2006). Of this, approximately 441 to 600 (~1%) nests occurred in North Carolina with approximately 57 to 78 (~0.1%) nests occurring along 22 miles of Topsail Island (MacAllister, 2006; SCDNR, 2006). The total number of nests for *C. mydas* (9,642 in FL, 0 to 5 in NC, no records for GA, SC) indicates no more than 0.05% of total green turtle nesting occurred in North Carolina, with none reported along Topsail Island (FWRI, 2006; CRP, 2005; SCDNR, 2006; MacAllister, 2006). The total number of nests for *D. coriacea* (782 in FL, 1 in GA, 0 in SC, 8 to 9 in NC) indicates

1.1% of total leatherback nesting occurred in North Carolina, with none reported along Topsail Island (FWRI, 2006; CRP, 2005; SCDNR, 2006; MacAllister, 2006).

The study of the effects of beach renourishment on sea turtle nesting was examined on Bogue Banks, where beach nourishment occurs on a regular basis. Between 2002 to 2007, there were 349 nesting activities on Bogue Banks, the majority of which were made by loggerhead sea turtles. There were a total of 167 nests, and all but three were laid by loggerhead sea turtles. In 2005, there were 2 leatherback nests and one green turtle nest observed on Bogue Banks. When examining the nesting rates along nourished and unnourished beaches, results showed that there was no discernable impact of nourishment on nesting behavior or hatching success for loggerhead sea turtles (Holloman and Godfrey, 2008).

Based on indications from the State of Florida where (1) significant turtle nesting occurs; (2) extensive nourishment/renourishment projects have taken place; and (3) stewardship of this resource is encouraged through research, education, and volunteer activities, it appears that the cumulative effect of these activities is neutral to significantly positive. Considering the magnitude of nesting by this resource in North Carolina, the cumulative effect of similar activities is likely to be neutral or positive since turtle nesting habitat area will be maintained or increased through future nourishment and renourishment projects. Furthermore, dredging and fill placement activities will be conducted during winter months when sea turtle nesting does not occur. Other minimization and avoidance measures, including the utilization of beach compatible material, will reduce the chance of negative impacts to sea turtles.

Intertidal Flats and Shoals, Salt Marsh and Water Column Resources

Dredging projects carried out since the 1940's in combination with catchment alterations (residential, industrial and agricultural) have significantly altered the natural ecology and hydrology of coastal areas throughout the geographic scope. Water quality has been affected by inputs of nutrients, pollutants and terrestrial sediment. Natural channels and flow pathways have been altered leading to habitat modification of these resources. Inlets have been deepened and widened to improve navigation and flushing. The abundance, distribution and taxa of species associated with these resources have changed in response to habitat modification. In the vicinity of the project area, Cedar Bush Cut and AIWW have been maintained to facilitate navigation and access to the Atlantic Ocean. This access supports commercial, recreational and military activities. Dredge spoil removed during maintenance activities has contributed to shoal formation and beach nourishment. The proposed project seeks to combine continuing maintenance of the New River Inlet with protection of North Topsail Beach infrastructure.

The magnitude and significance of disturbance to the ebb tide delta shoal for the proposed project and future maintenance projects is considered temporary and minimal due to the dynamic nature of this resource and its spatial and temporal separation from other similar projects. The material removed to maintain the preferred channel alignment and position would be bypassed to North Topsail Beach and used to maintain the beach project. This artificial sand bypassing element of the overall management plan would

provide a much more efficient sand bypassing mechanism compared to the amount of material naturally moving past the inlet. While most of the material removed to maintain the inlet would be bypassed to North Topsail Beach, a monitoring program would also evaluate impacts north of the inlet. Under existing conditions, sand movement around New River Inlet occurs sporadically both in terms of direction and quantity. The implementation of an inlet management plan with a sand management component would improve the overall conditions of the adjacent island and would not alter the dynamic development of intertidal flats and shoals.

There is potential for intertidal flats and salt marsh to be affected by temporary increases in turbidity associated with the proposed project and future maintenance projects. The magnitude and significance of this effect is considered minor due to the relative position of these resources within or adjacent to the project area, adaptation to naturally high ambient turbidity, and exposure to tidal flushing.

The magnitude and significance of the proposed project's effects on the water column resource is not considered to be outside the natural range of effects associated with high wave energy and storm events. The mechanical entrainment and resultant mortality of marine organisms associated with dredging activity has been evaluated and considered to be insignificant for the populations potentially affected (Settle, 2005). The magnitude and significance of environmental consequences associated with the proposed project, and other temporally and spatially separated projects, are considered to be neutral.

Nearshore Hardbottom Resource

Historical navigational improvements and maintenance to the New River Inlet, estuary, Cedar Bush Cut and AIWW are estimated to have increased the tidal prism at this coastal inlet by a factor of five (CPE, 2004). Increasing the tidal prism results in increased transport of suspended sediment, nutrients, pollutants and tannin enriched water into the nearshore marine environment. Species associated with ephemeral nearshore hardbottom have adapted to this high energy, turbid, low light environment. The magnitude and significance of environmental consequences associated with the proposed project which is designed to reduce project associated turbidity and sedimentation by inclusion of a perched beach design, cutterhead suction dredge, selection of low silt content borrow areas, and 400 foot buffer zones; combined with the temporal and spatial separation of similar projects, are considered to be neutral.

Offshore Hardbottom Resource

The cumulative effects associated with the historic activities discussed for the nearshore hardbottom resource are applicable to the offshore hardbottom resource. Diver observations, before and after Hurricane Ophelia in September 2005, indicate this resource is significantly influenced by storm activity and flood flow emanating from the New River catchment. The magnitude and significance of environmental consequences associated with the proposed project, combined with the temporal and spatial separation of similar projects are considered to be neutral.

10. Modify or Add Alternatives to Avoid, Minimize, or Mitigate Significant Cumulative Effects

The proposed project was previously modified to minimize project effects on salt marsh adjacent to the project area by eliminating dredging in Cedar Bush Cut. A dike will be constructed around the portion of the upland disposal site where material is to be placed. The Town will work with the dredge contractor to put in place protocol such as properly placed outfall pipes and construction of weirs to assure that water flowing back into the AIWW via the outfall pipe will meet state water quality standards and not present impacts to nearby salt marshes.

In order to minimize potential effects on nearshore hardbottom resources, a perched beach has been designed to utilize coarser grain size material that will be less easily transported offshore. A 400 foot buffer zone has been proposed to minimize potential effects to the adjacent hardbottom resources. Four 60 m (200 ft) wide corridors were selected to avoid impacts to hardbottom resources identified from sidescan sonar surveys and diver groundtruthing surveys conducted off North Topsail Beach. All four corridors are positioned approximately 137 m (450 ft) or greater from the edge of hardbottom resources.

The use of a cutterhead suction dredge has been proposed for this project to minimize turbidity effects from the dredging operation in the borrow areas and reduction on sea turtle takes. Beach compatible material will be utilized for beach nourishment. This will improve the recovery rates of infaunal resources and will ensure continued nesting success for sea turtles. Specific protocol, such as construction observation, will be in place during the initial dredging of the ocean bar channel at New River Inlet to determine if clay is being placed on the beach and to alter dredge practices to prevent any additional clay from being dredged. These protocols will include coordination of observers and the contractor to alter dredge and fill activities if incompatible material is observed to be dredged and placed on the beach. If incompatible material is placed on the beach, the USACE and appropriate resource agencies will be contacted immediately to determine appropriate actions.

Dredging and beach nourishment activities will occur during the winter months when sea turtles and shorebird nesting activity is inactive.

Additional avoidance and minimization measures are included within Section 6 of the FEIS.

The preceding steps in this CEA analysis have identified certain resources which are likely to be negatively impacted by the cumulative effects of the proposed project. Those resources include infaunal species and shorebirds.

The adverse effect on infaunal species is short-term due to their ability to recover rapidly (2 to 6.5 months). This rapid recovery rate is associated with the presence of local recruits available for re-colonization. To minimize the adverse effects on this resource,

nourishment projects should be spatially and temporally separated to allow for recovery. The phased approach included in this proposed project will ensure that generally no stretch of beach along North Topsail Beach will be renourished generally within a four year period. Furthermore, a monitoring plan or research initiative for the evaluation of oceanfront shoreline infaunal communities as described below and will be implemented by Dr. Skip Kemp of Carteret Community College.

Shorebirds that are easily disturbed and displaced from their habitat are adversely affected by the human community and associated avian predators. Beach nourishment projects allow the human community to sustain and develop the coastal environment. Reducing the impact of the human community and predators on these shorebirds, requires avoidance, which is increasingly impractical when human access is permitted to all coastal areas. Therefore, alternatives available to minimize and mitigate the human impact to this resource should incorporate a combination of habitat enhancement, increased research, public education and encouragement of stewardship by the human community. Research oriented toward identifying the habitat requirements for targeted species will allow future creation, enhancement and/or protection of habitat.

Overseas experience has shown that creating shell-hash nesting habitat which simulates natural overwash habitat, but at elevations preventing flooding of nests, provides two desirable factors for successful shorebird reproduction: (1) the necessary camouflage for eggs and (2) open views for predator sighting (LaBonté, personal experience – Mangawhai Harbour Restoration Project, New Zealand). Enhancement of public awareness through education and involvement of coastal human community members in research, monitoring and protection of targeted species can be used to develop a sense of psychological ownership (stewardship) for targeted species.

11. Monitor the Cumulative Effects of the Selected Alternative and Adaptive Management

This CEA has identified negative, neutral and positive impacts to the identified resources. The infaunal and shorebird resources are identified as being negatively impacted by past, present and reasonably foreseeable future similar activities.

In order to monitor cumulative effects on target resources, a baseline should be established for those resources. This CEA has identified the cumulative effects as being short and long-term, depending on the species.

Infaunal Resource

The impact of these activities on the infaunal resource has been identified as short-term (2 to 6.5 months) with expected recovery of the resource dependent upon recruitment from adjacent, unaffected areas. Previous research on this resource has occurred outside the project area and outside the geographic scope identified in this CEA (Burlas *et al.*, 2001).

In order to establish a baseline within the geographic scope for this resource, which has the potential to be impacted by multiple reasonable foreseeable future projects, a baseline and post-project monitoring program along the affected beach would serve to extend the knowledge base related to the impact of nourishment and renourishment projects on this resource.

Shorebird Resource

The impact of these activities on the shorebird resource has been identified as long-term. Development of this CEA has revealed a paucity of data relating to shorebird resources in the project area. This deficiency of shorebird data appears to correlate with a lack of formalized data collection programs associated with minimal funding. As a result the data is sporadic, often being collected on an occasional basis.

Accordingly, the establishment of a formal shorebird monitoring and enhancement program has been established. This monitoring program would:

1. Establish a scientifically robust baseline shorebird resource and long-term monitoring program;
2. Enhance habitat through creation of elevated, shell-hash nesting areas which mimic natural overwash features;
3. Foster increased public awareness of the shorebird resource;
4. Provide educational and research opportunities for a range of age groups and learning institutions;
5. Encourage stewardship of the shorebird resource through establishment of community care groups.

Pre-construction bird monitoring began in 2007 and was completed in 2009. Post-construction monitoring efforts will be reviewed and coordinated with the USACE, NC DCM and NCWRC. The length of post-construction monitoring will be dependent on the review the data by the USACE, NCDCM, and NCWRC.

These monitoring programs should mitigate the indirect effects associated with past, present and future nourishment and renourishment projects identified in this CEA.

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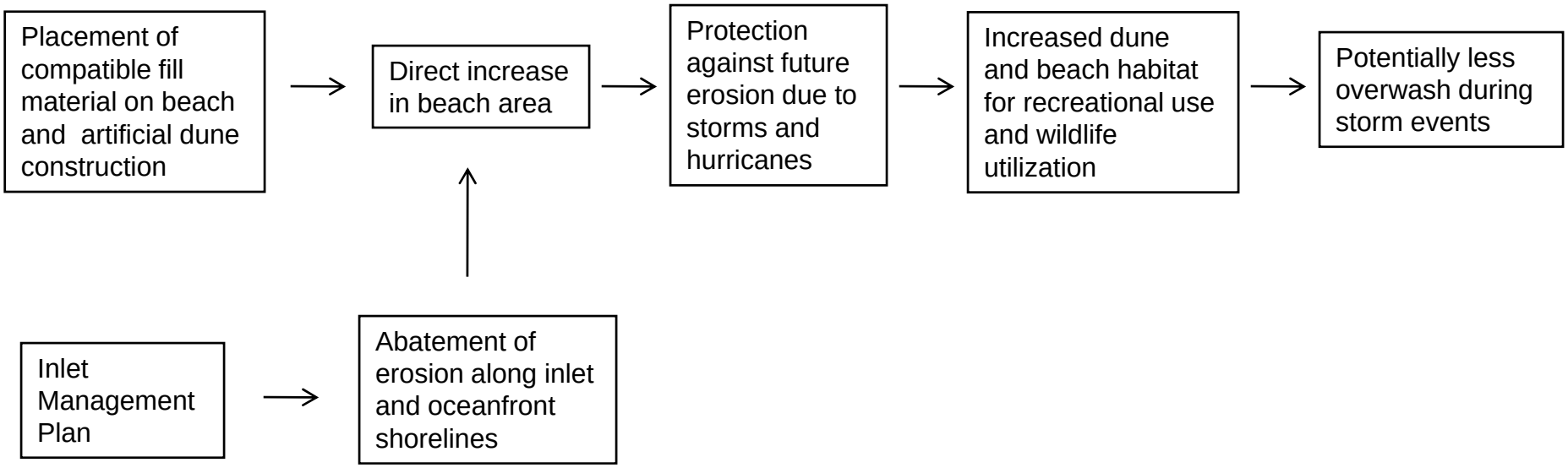
Cause and Effect of North Topsail Beach Shoreline Protection Project on Beach and Dune Habitats



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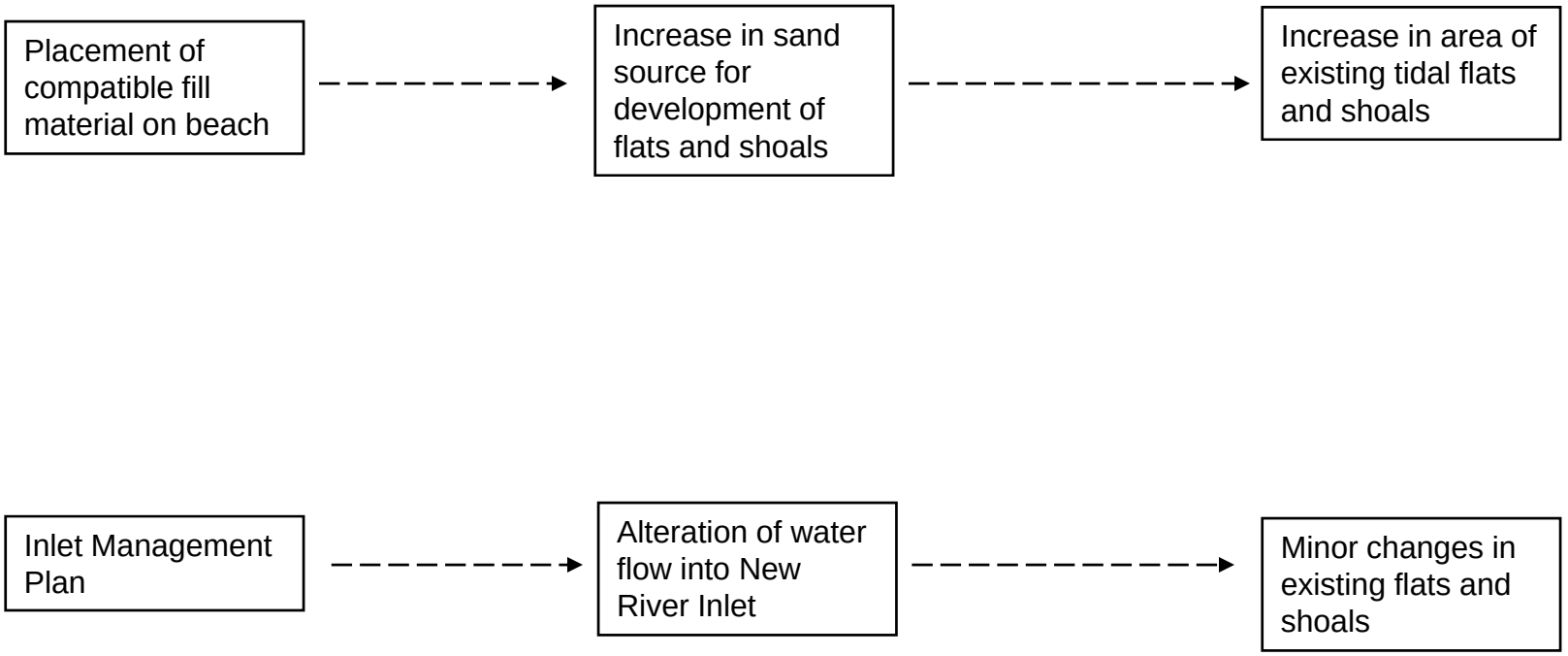

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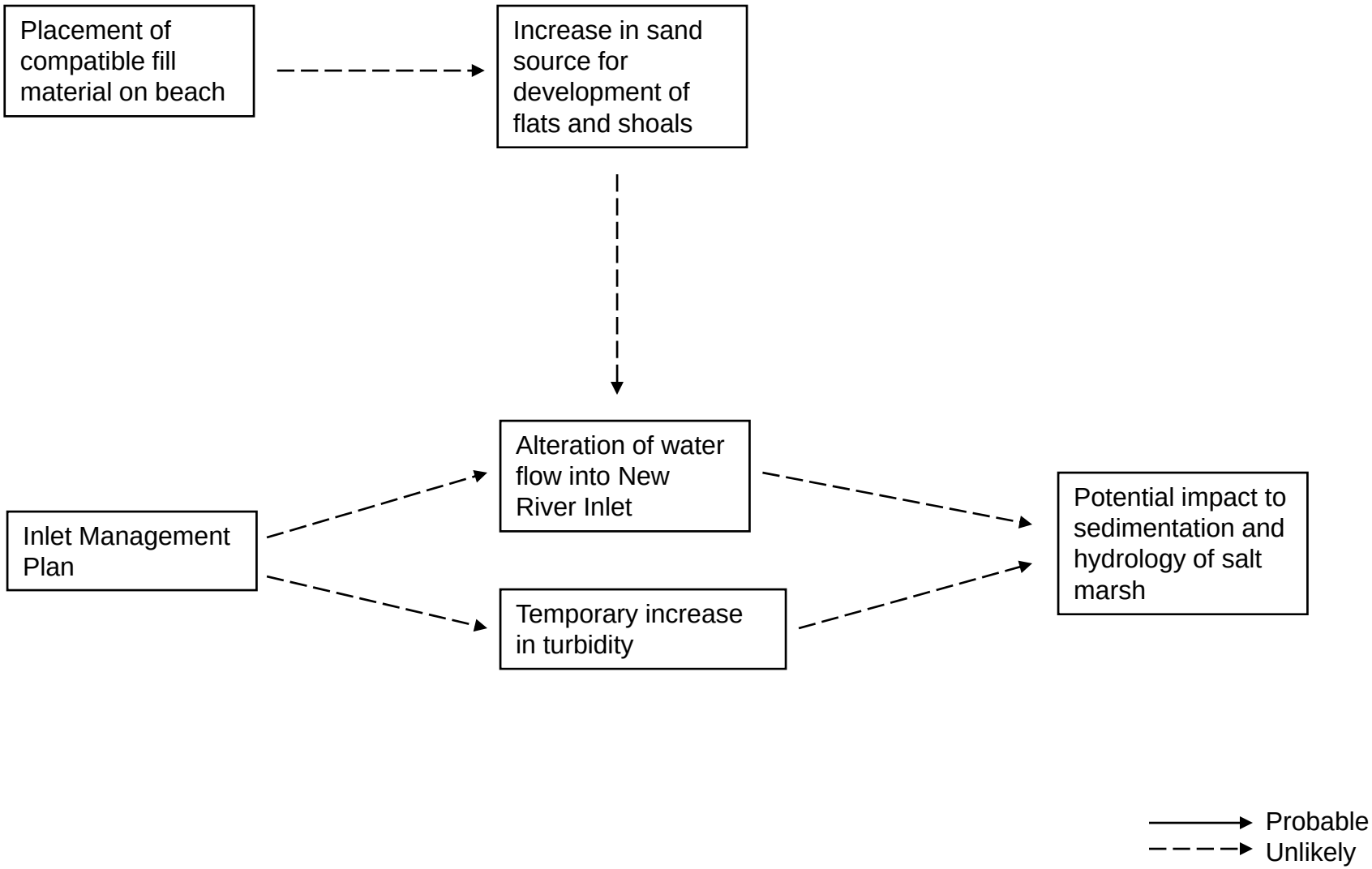

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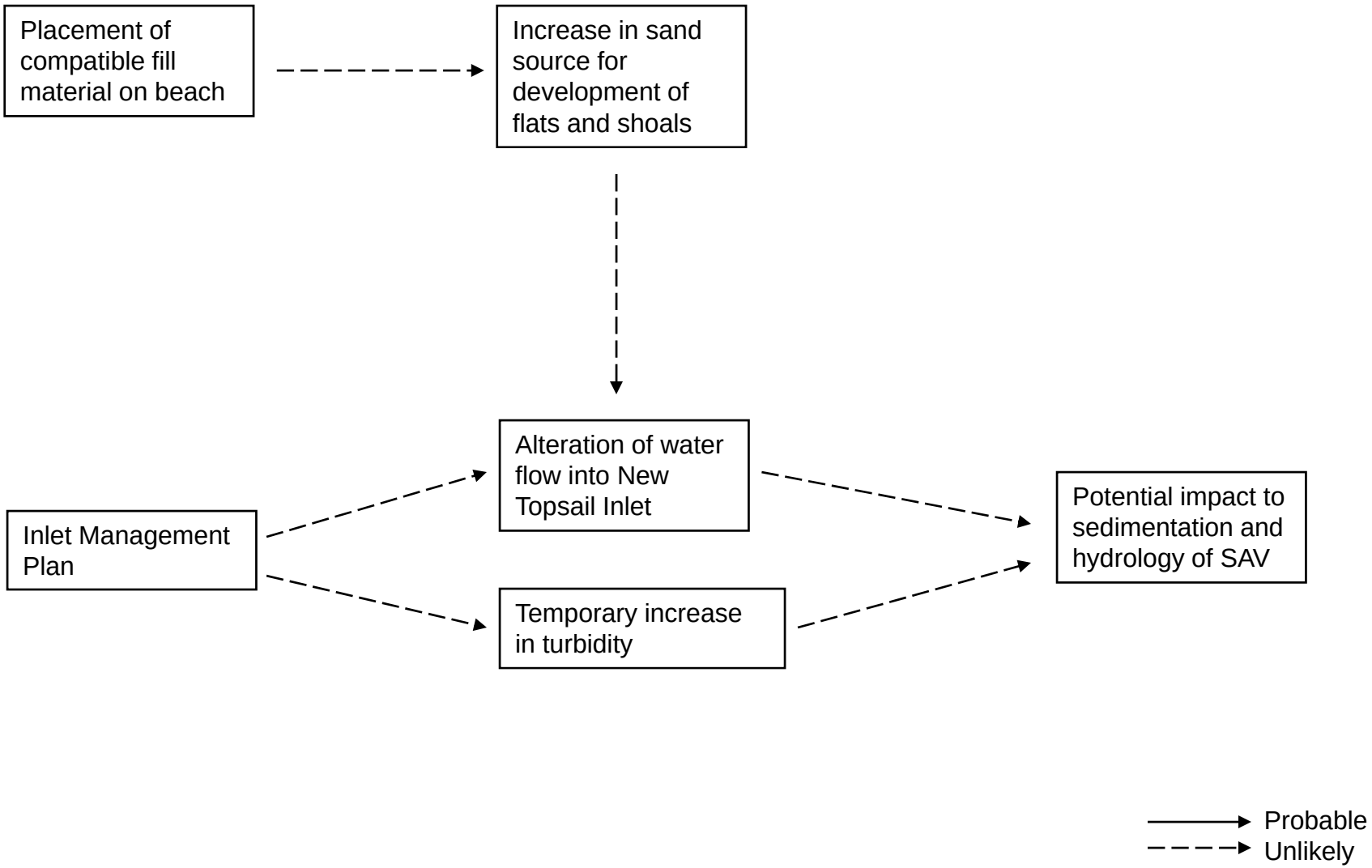

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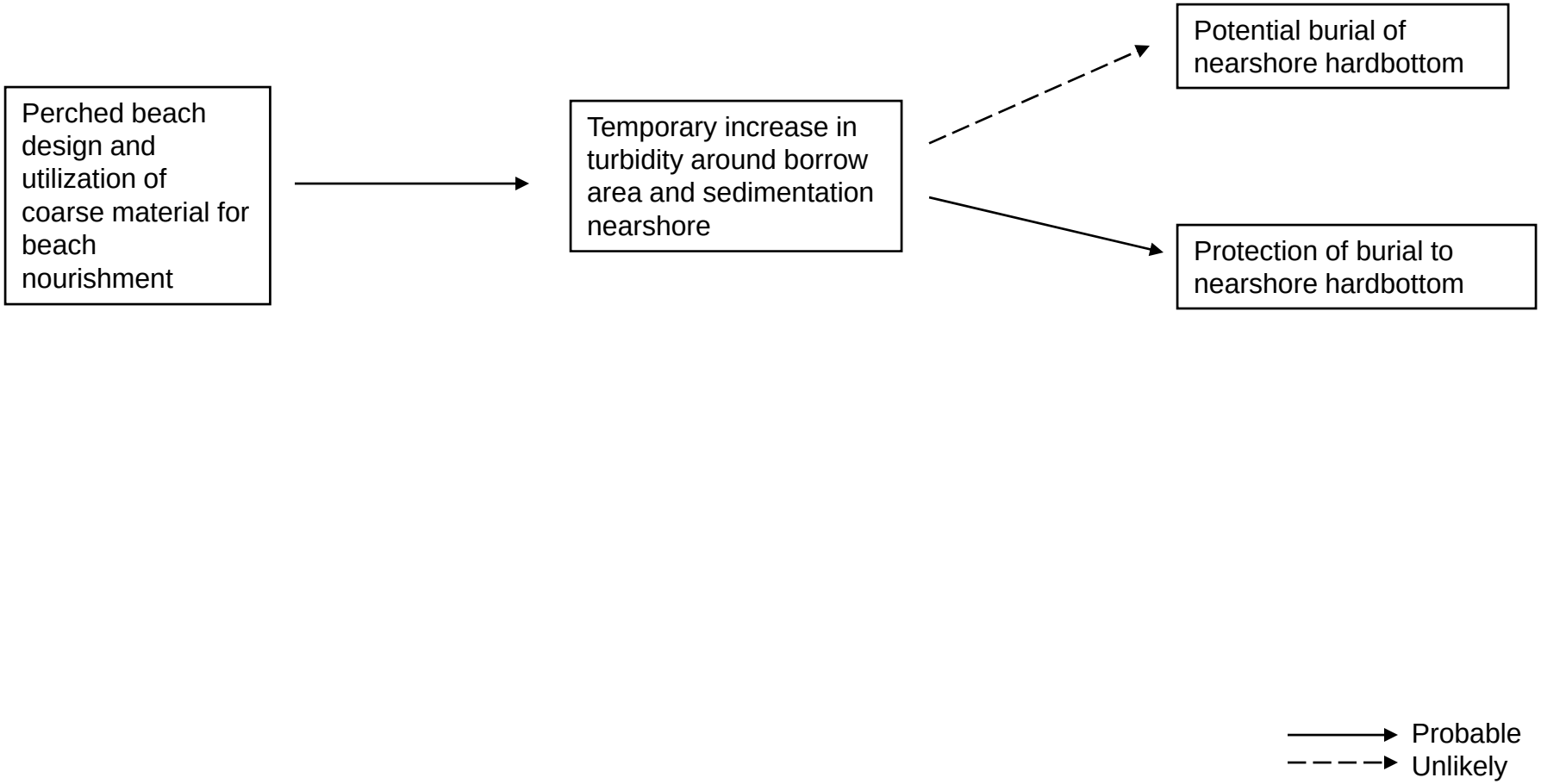
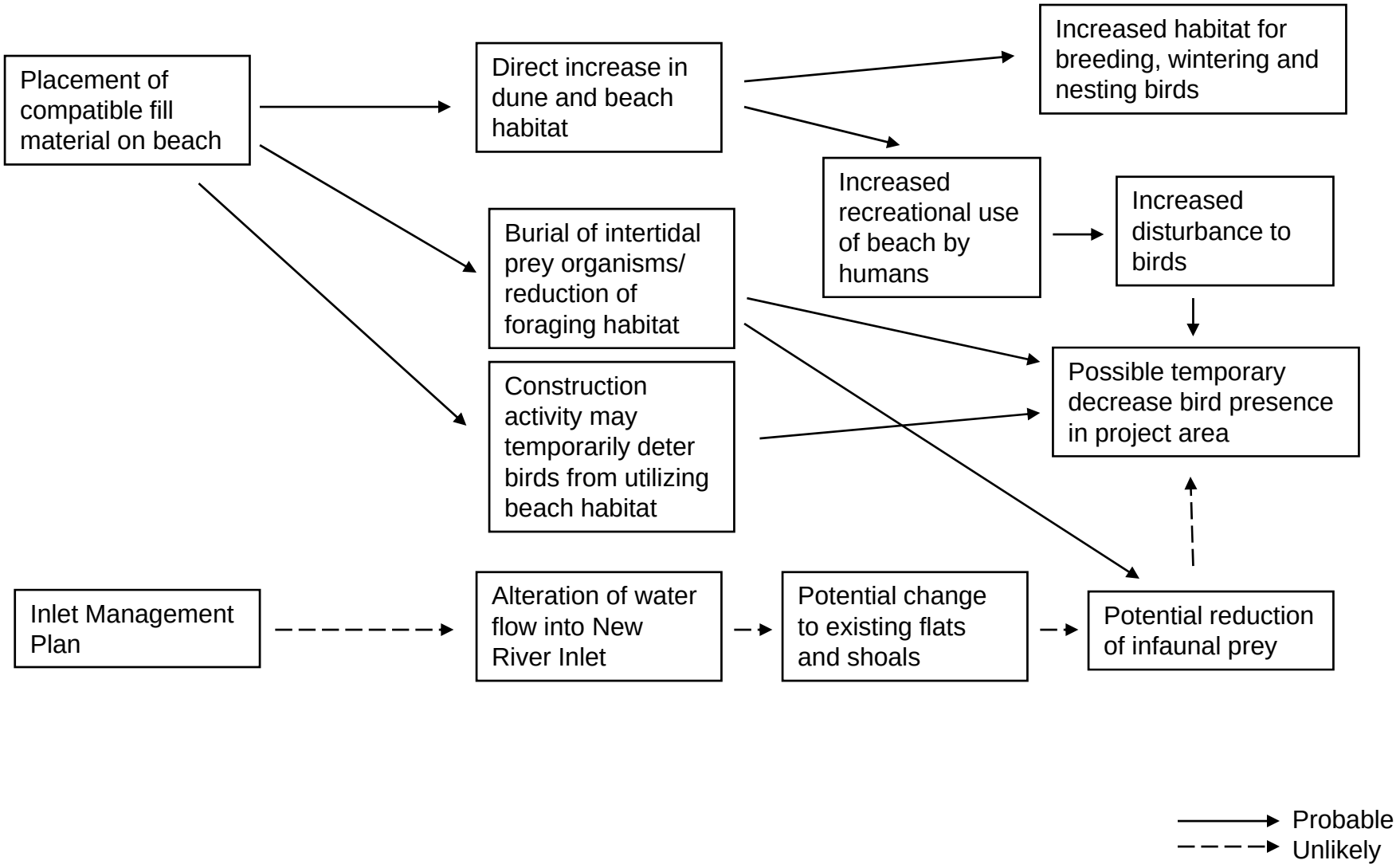


Cause and Effect of North Topsail Beach Shoreline Protection Project on Resident and Migratory Bird Resources



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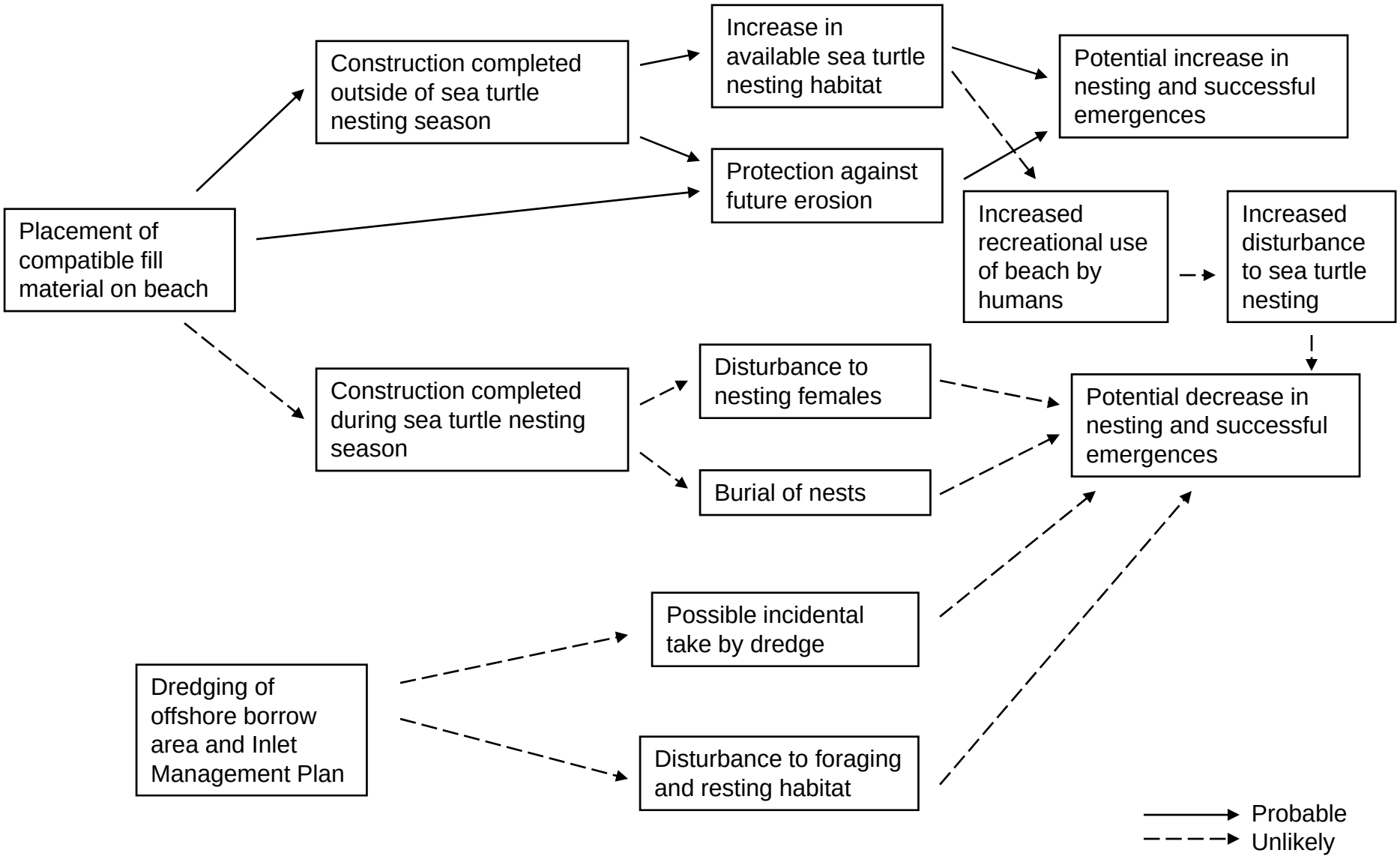

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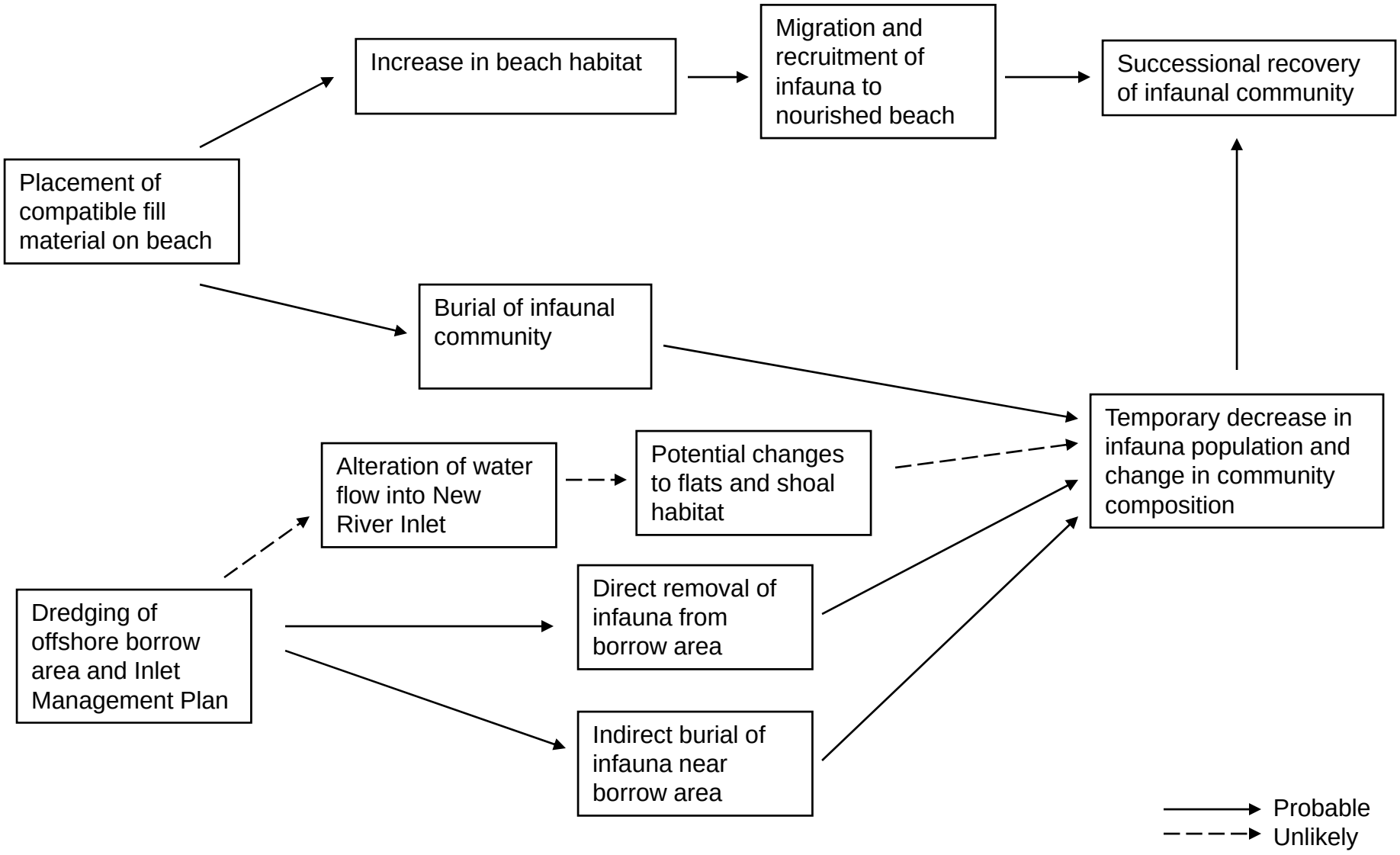

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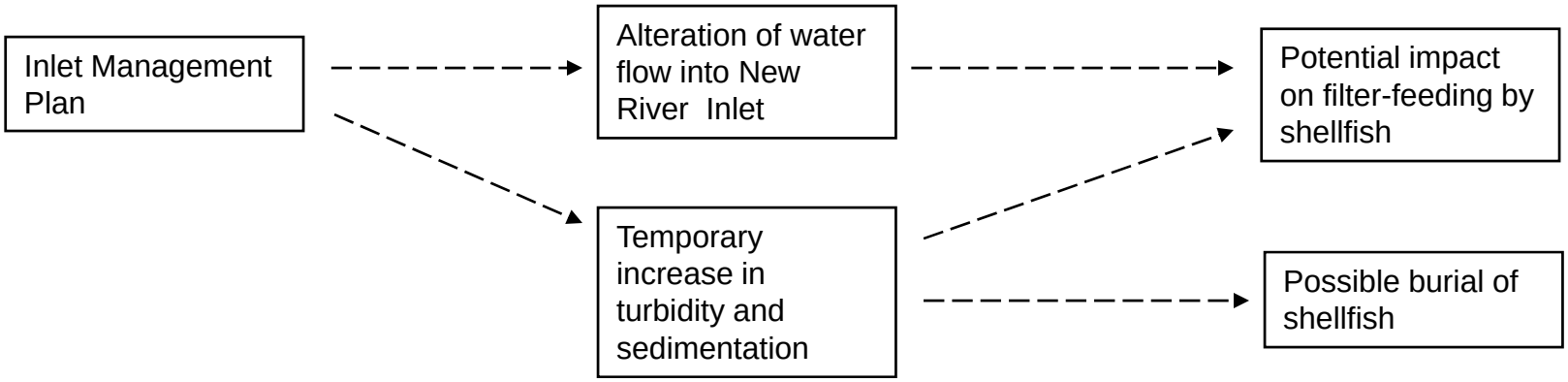
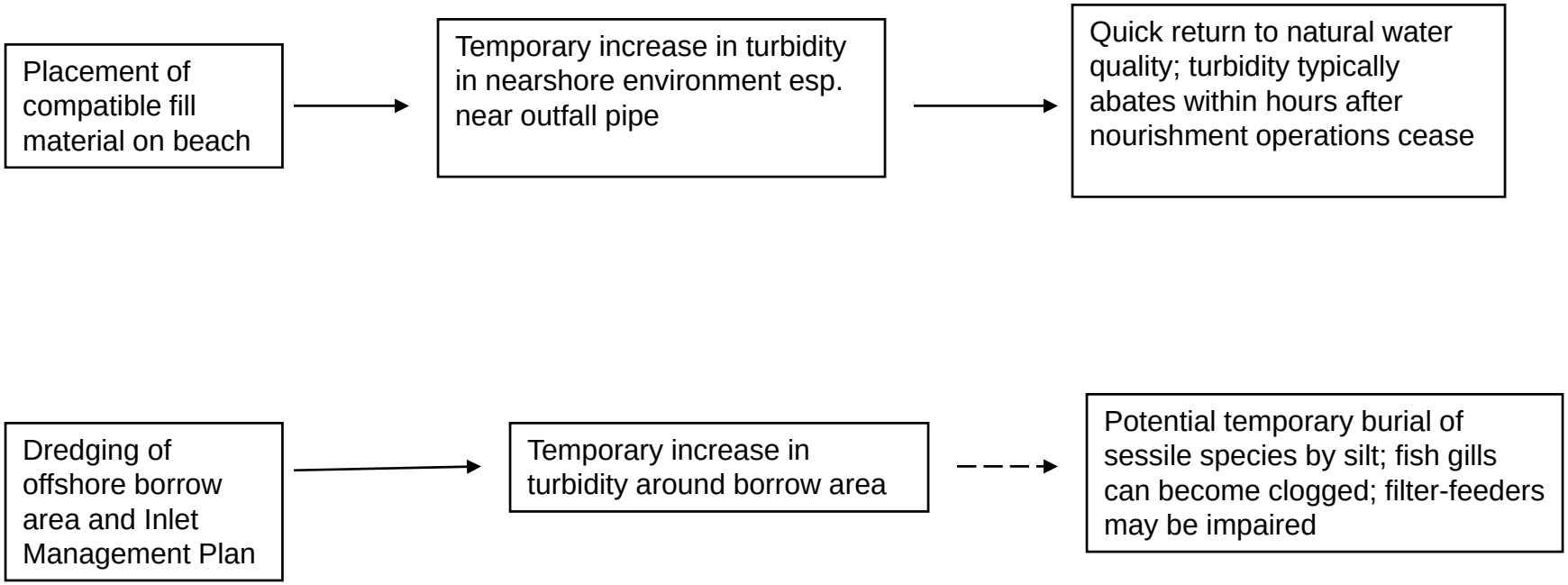


Probable
Unlikely

Cause and Effect of North Topsail Beach Shoreline Protection Project on Water Quality



Appendix 2: Cumulative Impacts Table

Resource	Past Actions	Present (Proposed Action	Future Actions	Cumulative Effect
Dune, Beach, and Overwash	Loss to erosion by storms, hurricanes and sea level rise. Coastal development impedes natural migration of the barrier island.	Increase total area, protect resources from future erosion, reduce overwash habitat due to artificial dune creation.	Regular renourishment of beaches will continue to protect resources from erosion.	The cumulative effects of repeated beach nourishment projects on these resources are anticipated to be positive; they will maintain and sustain these resources and create additional habitat for wildlife utilization and human recreation.
Tidal Flats and Shoals	Subject to natural changes in the inlet	No significant impacts are expected.	Future renourishment projects are not expected to alter the dynamic formation of flats and shoals in the New River Inlet complex.	There are no anticipated cumulative effects from repeated beach nourishment projects as dredging from the inlet and offshore borrow areas should not alter tidal flats and shoals.
Salt Marsh	Loss of salt marsh to development, changes to hydrology, pollution, and invasive species.	No significant impacts are expected.	Future renourishment projects are not expected to impact salt marsh	There are no anticipated cumulative effects from repeated beach nourishment projects to the salt marsh communities as these resources are distal to project activities.

Submerged Aquatic Vegetation (SAV)	Dredging, pollution, and invasive species threaten SAV communities	No significant impacts are expected.	Future renourishment projects are not expected to impact SAV.	There are no anticipated cumulative effects from repeated beach nourishment projects to the SAV communities as the main threat, turbidity, would be a short term impact.
Hardbottom Habitat	No significant threats to hardbottom resources in project area.	Buffer area and the perched beach design and utilization is expected to protect hardbottom habitats from sedimentation thereby eliminating impacts.	Future projects will maintain a buffer between dredge and hardbottoms minimizing resource impacts.	Due to the perched beach design and utilization of coarse material in stretches in proximity to hardbottom resources, no cumulative effects are anticipated.
Birds Resources	Habitat loss due to coastal development and shoreline armoring.	An increase in beach habitat will result, however temporary burial of intertidal prey as well as disturbance during construction will provide minimal impacts.	Future renourishment projects will maintain and protect beach habitat, however prey resources will be temporarily impacted.	No long term cumulative effects are anticipated for bird populations, however there will be temporary disturbance by beach construction and burial of intertidal prey resources associated with each beach nourishment project.
Sea Turtle Resources	Erosion, coastal development armoring, and artificial lighting threatens sea turtle	Direct increase in available nesting habitat.	Future renourishment projects will maintain and protect beach habitat.	Cumulative effects to sea turtle resources are anticipated to be positive as increased nesting

	nesting habitat.			habitat will be created.
Infauna Resources	Previous nourishment projects and natural changes within inlet complex alter infaunal community composition	Temporary removal of infauna from borrow area and burial of infauna from fill placement.	Future reourishment will regularly cause temporary direct disturbances to infaunal communities.	Repeated beach nourishment projects will regularly disturb infaunal communities through the removal from borrow sites and burial. The current temporal spacing of these projects appears to allow for recovery of infaunal communities between projects.
Shellfish Resources	Increased coastal development increases pollution and nutrient loading thereby decreasing water quality and threatening shellfish	No significant impacts are expected.	Future renourishment will not impact shellfish resources.	There are no anticipated cumulative effects from repeated beach nourishment projects to the shellfish resources as the main threat, turbidity, would be a short term impact.
Water Quality	Agriculture and coastal development contribute pollution and nutrients to coastal waters, decreasing water quality.	Short-term increase in turbidity by offshore borrow area and within New River Inlet.	Future renourishment projects will cause temporary increases in turbidity.	There are no anticipated cumulative effects from repeated beach nourishment projects to water quality as the main threat, turbidity, would be a short term impact.